V

Dairy

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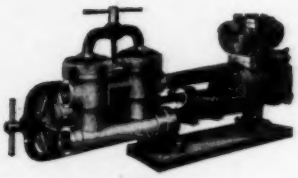

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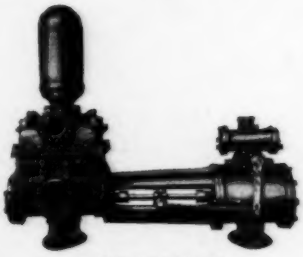

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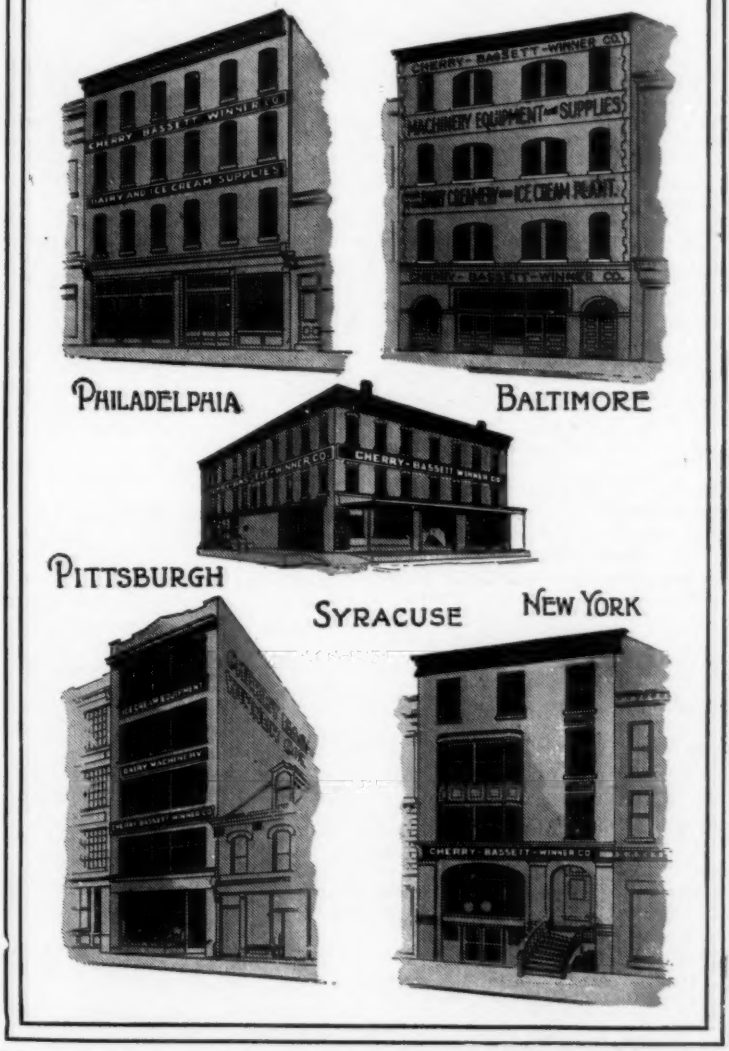

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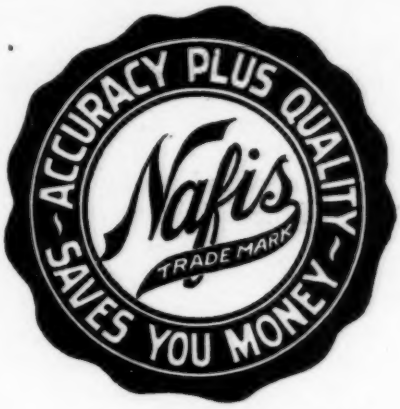

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BLINDNESS AND OTHER DISEASES IN CHILDREN ARISING IN CONSEQUENCE OF DEFICIENT NUTRITION (LACK OF FAT SOLUBLE A FACTOR)[1]

DR. C. E. BLOCH

Professor of Medicine, University of Copenhagen, Copenhagen, Denmark

Received for publication October, 1923

While blindness in children has been on the decrease in the greater part of the civilized world, the opposite has taken place in Denmark. Blindness in children has increased not only absolutely but also relatively to the population. Many causes have contributed to the diminution of blindness in other countries, but the chief one undoubtedly is that gonorrhoeal opthalmoblenorrhoea in the newborn has become a rare disease as a result of the special measures which have been adopted against it everywhere. That gonorrhoeal opthalmia has become a rarity also applies to Denmark but in spite of this the percentage of blindness in children is increasing.

There is however, another disease of the eye peculiar to childhood which leads to blindness. This is xerophthalmia. It was first described in the middle of last century by German ophthalmologists. According to all previous reports xerophthalmia had a very serious prognosis as it occurred particularly in the final stage of a cachectic condition due to a protracted wasting disease such as tuberculosis, syphilis, typhoid fever, acute or chronic digestive diseases, etc., and especially in badly nourished and debilitated children.

In the middle and close of last century and in the beginning of this, "epidemics" of an eye disease were described which were undoubtedly indentical with xerophthalmia. These "epidemics" occurred among negro children in Brazil, during periods of

[1] This paper was read by Dr. C. E. Bloch before the World's Dairy Congress, Washington, D. C., October 3, 1923.

fasting in Russia, when famine and summer diarrhoea accompanied one another in Japan, and it was always the badly nourished and diseased children of the poorer classes who were attacked. The majority of the authors who have described these epidemics therefore associate xerophthalmia in children with a bad and deficient diet. Primitive medicine in Japan, Russia and other countries has from ancient times treated this eye disease with fat substances, especially cod liver oil and liver, and Mori has declared that the disease is due to lack of fat in the diet.

In Europe xerophthalmia is considered to be extremely rare. A few cases have previously been recorded in badly nourished children in England and Denmark, while in Germany, Czerny and Keller and, according to them, several others, have now and again observed xerophthalmia in the final stage of the nutritional disease they call "Mehlnahrschaden."

The Children's Department of the Danish State Hospital was opened in 1911. Even by the next spring a number of children were admitted with a curious eye disease which proved to be xerophthalmia, and in the following year the number increased to an alarming extent. I thus, had the opportunity of studying this disease in its different forms and stages, about which I published communications, some long and others short, in 1914, 1916, 1917, 1918 and 1922.

My investigations indicated that the disease was due to a lack of a particular substance. This substance was present in fresh milk, but not in separated or butter milk. It was therefore united with the butter fat and it was also found in abundant quantities in cod liver oil. My investigations further showed that the disease could not be attributed to the absence of fat as such, because even though the children had received margarine or pork fat they could easily get xerophthalmia.

In England and America (U. S. A.) a large number of experimental investigations into nutrition were carried out partly before and partly at the same time as my work. From these enquiries we became further acquainted with the cause of xerophthalmia and the disease associated with it. It was from the animal experiments of Osborne and Mendel, and especially of

McCollum and his collaborators that we know now the cause of xerophthalmia is the lack of the fat-soluble A factor. This body which is united with certain fat substances and is notably found in large quantities in butter and cod liver oil, must be constantly supplied to the organism, particularly the growing organism, in order that growth shall take place; deprivation for a long period leads to xerophthalmia and death.

When a child, particularly one in the first few years of life, is deprived of its mother's milk or fresh milk, as well as cream and butter, and is kept for a long time on a diet consisting of puddings made with separated or butter milk, bread and other farinaceous foods, potato-mash, a little pork and other meat, margarine, and pork fat, it will become ill as a result of the absence of the fat-soluble A factor. Even if the child eats a little vegetable, fruit and green-stuff now and again it will not help much, for a small child can only digest trifling amounts of green-stuff.

A deficiency of the fat-soluble A factor may also occur in children who have received a quantity of pure milk but in such cases the milk must have been stale and modified adversely, the fat-soluble A factor being destroyed by oxidation and repeated heating.

The disease is ushered in by the child ceasing to gain weight. Later on there is a loss of weight and the child remains motionless and apathetic. In other words there is *inhibition of growth* and depressed *psychic and bodily vitality.*

These children are liable to be attacked by some infectious disease which usually takes the form of a simple catarrhal infection of the mucous membranes particularly of the respiratory organs and middle ear. *B. coli* infections of the urinary tract and infectious dermatitis are also frequently observed. These infections are extraordinarily persistent and often have a vital issue. An *increased susceptibility* and a *diminished power of resistance* against infections are therefore present.

The eye lesion does not appear as a rule until late in the disease. It first occurs in the form of night-blindness

(hemoralopia) and dryness of the ocular conjunctiva (xerosis). The dryness later extends over the cornea which becomes hazy, shrivels up, and shortly after, pieces of it become necrossed (keratomalacia). In most cases the ocular conjunctiva is infected; the child then has photophobia, the conjunctiva is red, swollen, and the eye begins to water. When the cornea necroses the inflammation spreads to the interior of the eye. The in-

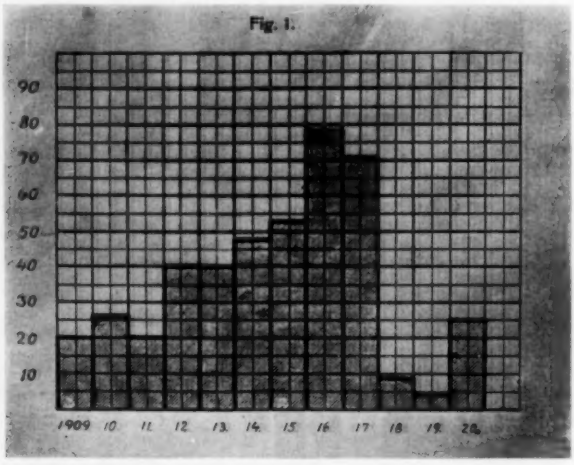

FIG. 1. CHART SHOWING NUMBER OF CASES OF XEROPHTHALMIA FOR 1909 TO 1920 IN DENMARK

Note the remarkable drop in the year 1918 and 1919 when the government rationed 0.25 kgm. of butter a week to each person in the kingdom. In 1920 rationing ceased; note increase in disease.

flammation may be so intense and widespread in many cases that it almost obscures the original xerosis. The eye lesion can only be distinguished with difficulty from the destructive inflammation in such cases.

If the disease is not recognized in time the child becomes blind. If the child does not then die of a secondary infection first, the most frequent cause of death is pneumonia.

In figure 2 such a patient is seen, a boy of about two years. He appears to be a healthy child, eyes only being swollen and

kept tightly closed. He is however, of small size and weighs less than normal. He also has a catarrhal infection. His eyes held

FIG. 2. SHOWS EYE DISEASE KNOWN AS XEROPHTHALMIA, MORE OR LESS COMMON AMONG CHILDREN FED A DIET WITHOUT SUFFICIENT BUTTERFAT

open are seen to be completely destroyed. The conjunctiva is swollen and red, both corneae are necrotic and there is pus in the anterior chamber.

The child was cured but became totally blind as the cornea never heals with clear transparent tissue. The scars are always hazy and opaque. In cases where the cornea is only partly damaged the child however may usually be saved from complete blindness.

If a small child receives no milk whatever, not even separated milk or butter milk, but is only given water, tea, gruel and the like for a prolonged period on account of diarrhoea or other

FIG. 3. SHOWS HOW XEROPHTHALMIA IS ARRESTED WHEN BUTTERFAT IS ADDED TO RATION

malady, the child will diminish in size and become atrophic, with dry wrinkled skin, but otherwise it will resemble the first type.

In one such case, in addition to the absence of the fat-soluble A factor several others are missing, but it is essentially the primary wasting disease—in this instance the intestinal trouble—which dominates the entire clinical picture. Such a case answers most nearly to the xerophthalmia described by the older authors.

When the child is a little older and stronger, and not ill, it can apparently thrive for a long time on infant food or other essen-

tially carbohydrate diet, but sooner or later, the tissues become oedematous, and if the child has received no fresh milk, xerophthalmia and pneumonia, etc., may supervene just as in the first type.

If the child had only a little butter in addition to the carbohydrate diet, oedema, like that in Bright's disease, can certainly occur but neither xerophthalmia nor marked changes in resisting power are observed, and the child is easily restored to health when it received milk.

Besides the xerophthalmia the characteristic symptoms in this disease which arises in consequence of the absence of the fat-soluble A factor are therefore inhibition of growth and diminished immunity and vitality. In bigger children and adults who hardly utilize so much fat-soluble A factor as the small child, the disease may be merely represented by the latter symptoms. It is only when the lack of the fat-soluble A factor in the food has been almost absolute for a long time or when the consumption of it has been very great, e.g., in chronic infectious diseases, that the bigger children get xerophthalmia also. It is chiefly the small children, that is to say those under two to three years of age, that get xerophthalmia and this may happen even though there has been some fat-soluble A factor in their food.

During the war there was much sickness among the bigger children in central Europe, which took the form especially of inhibition of growth, and a large number of infectious diseases running a grave course. Thus many children were attacked by tuberculosis. The smaller children on the other hand were remarkably little affected and xeropthalmia was hardly seen at all in them. This state of affairs was due to the fact that during the war all the milk and milk products in Germany were rationed so that every little child obtained a certain amount daily. If the child was being suckled by the mother she got the milk and xerophthalmia was never observed in children suckled by a mother capable of yielding sufficient milk.

In Denmark the conditions, as mentioned, were different; before and especially during the war there were many cases of xerophthalmia. In a recent investigation undertaken for the

Danish Ophthalmological Society 600 to 700 cases of xerophthalmia were found to have occurred between the years 1909 to 1920 in children in a population of less than three millions, and in addition to these there were probably others.

The reason xerophthalmia was so widespread, despite the fact that Denmark did not take part in the war, is that this country is a dairy-farming one which manufactures and exports butter. During the war butter, and consequently fresh milk, became so dear that the poor could scarcely procure any of it and they were only able to obtain separated and butter milk which could always be had at a very low price. The number of cases of xerophthalmia increased therefore until 1918. In that year the disease was suddenly checked as will be seen from the chart. The reasons were several but the principal cause was undoubtedly that in 1918, on account of the German blockade, butter was rationed in Denmark, so that every individual including small children was entitled to 0.25 kgm. butter a week, and as there was practically no pork fat or margarine in the country everybody had to eat butter. Xerophthalmia ceased simultaneously. These facts show as clearly as an experiment that the absence of the fat-soluble A factor is the cause of xerophthalmia.

After the termination of the war the rationing of butter came to an end and xerophthalmia returned but it was rare compared with its former incidence. It was particularly noticeable that the severe cases no longer occurred. The people and the Danish doctors had got to know the disease and had learned how to avoid and treat it.

The disease caused by lack of fat-soluble A factor is cured by supplying the latter to the afflicted organism, best in the form of fresh milk, cream or cod liver oil. The xerophthalmia is the first to disappear; then the child begins to thrive and gradually throws off the infections. The latter are therefore cured by the administration of the fat-soluble A factor. This is in harmony with the old clinical experience that chronic infectious diseases, particularly tuberculosis, are improved by a diet rich in fresh milk, butter and cod liver oil.

The fat-soluble A factor is thus particularly important not only for the eye lesion but also for establishing immunity, and it is clear that a great deal of it is used up in infectious diseases. Large quantities must also be consumed during growth. This is most clearly evident from McCollum's animal experiments, but the study of xerophthalmia points in the same direction, as it occurs practically only in children, that is to say, in growing individuals. Moreover the disease appears especially in the spring months at which season the most marked growth of the child takes place. The cases occurring in this annual period of growth have always been complicated by serious infections or chronic diarrhoea.

It has been thought that the accumulation of cases in the spring was due to a different content of fat-soluble A factor in the winter milk (stall feeding) and the summer (milk grass feeding). It is possible that there is more fat-soluble A factor in the first "grass-milk" and that this has something to do with the disappearance of the disease in the summer, but a decreased fat-soluble A content in the milk cannot be the cause of the many cases arising in the growth-period of the spring because precisely the same distribution is found of cases that have received no milk or milk products at all for a long while.

This special relation between the fat-soluble A factor and growth, and between it and infections, has not been thought to be confined to this body but is also found in other deficiency diseases. Thus Alfred F. Hess has specially pointed out that the relation is somewhat similar in the case of scurvy, the disease which arises from the absence of the anti-scorbutic factor. Scurvy, like every other serious disease is undoubtedly able to affect growth and diminish the power of resistance against infections, but in the disease caused by lack of the fat-soluble A factor both these features are very strongly emphasized and in a special manner. Thus scurvy in contra-distinction to xerophthalmia is not particularly associated with childhood nor does it like xerophthalmia appear especially during the annual growth period. Moreover a statistical examination of my cases of scurvy shows

that this disease is far from being associated with infections to the same extent as xerophthalmia.

Finally, I will just mention that xerophthalmia and rickets are only very rarely met with together in the same child. Rickets can therefore hardly be due to the absence of the fat-soluble A factor in the food or in the organism.

What I have said there and proved to you, testifies to the enormous importance of milk as a food for the child. No other article can replace milk. Absence of milk from the diet or the inclusion of unfavorably modified milk is the origin of most serious diseases.

By ordering milk and especially cream and butter not only is this terrible eye diseases cured—which I believe will be discovered in every country when it is looked for—but these dairy products are of the greatest importance for growth and development, and for the cure of our greatest infectious diseases.

ON THE PROTEIN REQUIREMENT OF MILK PRODUCTION

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This experiment, conducted between February 28 and May 1, 1919, had for its object the determination of the smallest amount of a certain mixture of proteins which it is necessary to supply, in excess of the requirement for maintenance, in order to support the production of milk without drawing on the protein of the body. This study was undertaken as a war-time activity, a study of economy in the production of an indispensable food.

On account of the depletion of the staff of the Institute through military service it was impossible to prosecute this investigation on the most critical basis, and allowance for this unavoidable situation should be made. In spite of certain compromise procedures in method, however, the results are not without effect to contribute enlightening evidence.

The subjects of the experiment were 2 mature Jersey cows, nos. 869 and 884, aged four and six years, respectively, the former having calved 142 days, and the latter 58 days, prior to the beginning of the first experimental period.

With cow 869, therefore, the experiment covered days of lactation 143 to 205, and with cow 884, days of lactation 59 to 121.

At the beginning of the first collection period cow 884 had been bred 2 days, and cow 869 had been pregnant for 72 days. During the experiment, then, cow 884 was in days of gestation 3 to 65, and cow 869, days of gestation 73 to 135.

These 2 cows differed markedly in their character as milk producers, no. 869 being a persistent milker, of normal dairy disposition to produce milk, while no. 884 was not so good a producer,

and was characterized by having a short lactation period, and by a noticeable tendency to fatten. These points are of importance in relation to the behavior of these cows in the experiment to be discussed.

The general method of experimentation was by balances of intake, in the feed, compared with outgo in the milk, urine and feces, the experimental subjects being maintained in metabolism stalls so constructed as to provide for the collection of urine and feces together.

TABLE 1

Composition of feeds

FEED	DRY MATTER	TOTAL NITROGEN	FACTOR FOR PROTEIN	CRUDE PROTEIN	DRY BASIS					
					Crude protein	Digestibility coefficient protein	Digestibility, crude protein	Factor, true protein	Digestibility, true protein	Therms net energy, 100 pounds
	per cent	*per cent*		*per cent*	*per cent*	*per cent*	*per cent*		*per cent*	
Alfalfa hay	91.585	2.321	6.25	14.506	15.839	72	11.404	71/106	7.639	37.451
Corn meal	88.393	1.362	6.00	8.172	9.245	66	6.102	64/69	5.660	96.054
Linseed oil meal	90.246	5.692	5.50	31.306	34.690	89	30.874	285/302	29.136	97.811
Peanut meal	90.765	5.740	5.50	31.570	34.782	90	31.304	414/428	30.280	104.759
Oat straw	93.130	0.526	6.25	3.288	3.531	33	1.165	8/10	0.932	39.333
Corn starch	86.637	0.256	6.25	0.160	0.185	50*	0.092	1/10*	0.009	81.790

* Assumed.

The separate amounts of urine and feces were computed from the combined weight by the use of percentage figures based on crude fiber estimations on the combined excreta and on the feces alone as separately collected by attendants. This separate collection was made from 8:00 a.m. until 4:00 p.m. on two days at the end of each experimental period, these days being the last one of the experimental period proper, and the first thereafter.

The ration was maintained, during these two days, exactly the same as during the remainder of the experimental period.

The course of the experiment was followed by daily weights of the cows, before and after drinking, weights of combined urine

and feces, determinations of nitrogen in the excreta, weights of milk, and determinations of nitrogen in the milk.

The plan covered five periods of two weeks each, the protein content of the rations varying from period to period, but the energy being maintained constant.

As planned, the protein to be fed, in excess of an arbitrarily assumed maintenance requirement, was to be computed from the amount of protein in the milk produced during the preceding period, by multiplication by the following arbitrarily determined factors:

Period I. 1.6 times the milk protein
Period II. 1.3 times the milk protein
Period III. 1.0 times the milk protein
Period IV. 1.3 times the milk protein
Period V. 1.6 times the milk protein

TABLE 2

Daily rations of cows—kilograms, fresh basis

COW NUMBER		PERIOD I	PERIOD II	PERIOD III	PERIOD IV	PERIOD V
869	Alfalfa hay	3.696	3.130	2.606	2.899	3.696
	Grain	4.790	4.060	1.361	3.765	4.790
	Oat straw		0.908	3.375	1.802	
	Starch		0.460	1.047		
884	Alfalfa hay	3.871	3.130	2.534	2.314	3.498
	Grain	5.022	4.060	3.282	3.001	5.022
	Oat straw		1.340	1.948	2.435	
	Starch		0.262	0.916	0.995	

Note: The grain mixture was composed of corn meal 77.09 per cent, peanut meal 11.21 per cent, and linseed oilmeal 11.70 per cent.

Cow 884 refused 3.391 kgm. feed in period I, and 0.059 kgm. in period IV.

In the discussion of the experiment, however, it will be noted that this schedule of protein allowance was not followed exactly. In certain instances it was changed voluntarily; and in all cases the production of milk differed more or less from the previously computed amount. There are, therefore, considerable differences between this adopted schedule and the corresponding ratios which actually prevailed during the course of the experiment.

It was planned that each fortnightly period be subdivided as follows:

	days
Preliminary feeding period	5
Digestion period	7
Calculation of ration for next period	2

This plan prevailed throughout the experiment, except that the 5 day preliminary period was, in 5 cases out of the 10, shortened to 2 or 3 days by the necessity for readjusting the amount of feed.

The rations were composed of alfalfa hay, corn meal, linseed oilmeal, and peanut meal, with the further addition of oat straw and corn starch in certain periods to adjust the energy value of the ration.

Each ration contained the four feeds first mentioned in such amounts to supply true protein in the following proportions:

	per cent
By alfalfa hay	35
By corn meal	25
By linseed oilmeal	20
By peanut meal	20

In the adjustment of the energy value of the rations to the uniform plane of intake contemplated by the plan of the experiment the digestible true protein content of the oat straw and of the corn starch were considered as negligible.

TABLE 3

Daily rations of cows—kilograms, dry matter

COW NUMBER		PERIOD I	PERIOD II	PERIOD III	PERIOD IV	PERIOD V
869	Alfalfa hay	3.263	2.786	2.311	2.587	3.282
	Grain	3.999	3.437	2.863	3.195	4.071
	Oat straw		0.809	1.218	1.626	
	Starch		0.395	0.902		
884	Alfalfa hay	3.418	2.786	2.247	2.065	3.106
	Grain	4.192	3.437	2.784	2.546	4.268
	Oat straw		1.194	1.743	2.198	
	Starch		0.225	0.789	0.858	

Note: Cow 884 refused feed in period I to the amount of 0.356 kgm. per day, which is equivalent to 4.7 per cent of the total. This refused feed was analysed, and accounted for, in so far as this was possible.

The feeds used were analyzed in advance, and the rations computed from these analyses, assuming average coefficients of digestibility.

The rate of feeding was computed on the following basis: Maintenance requirement of digestible true protein, 0.5 pound per 1000 pounds live weight; digestible true protein of feed, in relation to protein content of milk in preceding experimental period, allowed at computed rates varying from 96.6 to 205.4 per cent of the milk protein, plus the maintenance requirement of protein; energy supplied, in relation to energy content of milk in preceding period, 105 per cent, plus energy requirement for maintenance, in accord with the Armsby standard of net energy.

The rates at which digestible true protein was actually fed, in comparison with the milk protein of the preceding period, are the following, the numbers being those by which it would be necessary to multiply the milk protein to equal the true protein of the feed.

PERIOD	COW 869	COW 884
I	1.60	1.60
II	1.30	1.30
III	1.027	1 028
IV	1.28	0.966
V	1.869	2.054

In comparison with the milk protein of the concurrent period the true protein of the feed was as indicated by the following factors, the significance of which is the same as in the above table:

PERIOD	COW 869	COW 884
I	1.67	1.78
II	1.36	1.46
III	1.08	1.14
IV	1.32	0.95
V	1.74	2.07

During the preliminary feeding, and also during period I cow no. 884 refused varying quantities of feed each day, the amounts

during the 3-day intermediate feeding being 0.700, 0.152, and 0.450 kilo; and during the 7-day collection period, 0.250, 0.402, 0.486, 0.978, 0.680, 0.574, and 0.021 kilo.

During the 5-day preliminary feeding of period IV this cow refused, per day, 0.078 kilo of feed; and in the collection period following she refused 0.059 kilo of feed.

Since the refusal of feed introduces error of undeterminable magnitude into metabolism experiments that data relating to cow 884 in periods I and IV rest upon a less certain basis than do the other results of the experiment.

Another unfavorable condition which requires mention is the shortness of the collection periods (7 days), and especially of the preliminary feeding periods (2 to 5 days).

The length of preliminary periods, as above stated, does not in all cases cover the entire time of preliminary feeding but only that portion of this time during which the amount of feed consumed was exactly the same as that given during the collection period to follow:

Length of preliminary feeding periods

PERIOD	COW 809	COW 884
	days	*days*
I	3	3
II	2	3
III	5	5
IV	5	5
V	5	3

Neither the preliminary nor the collection periods were of length adequate for the intended purpose, that is, to obtain evidence as to the protein requirements of milk production.

It is also unquestionably true that the basis of evidence upon which the amounts of urine and feces were computed, from the weight of the two combined, as collected, was slight.

However, in spite of those unfavorable conditions the results, as set forth in the tables, bring out clearly certain points of interest and value.

Table 4 sets forth the average daily amounts of nitrogen in the feed, milk and excreta, and the balance of income to outgo of nitrogen.

TABLE 4

Daily balances of nitrogen—grams

COW NUMBER		PERIOD I	PERIOD II	PERIOD III	PERIOD IV	PERIOD V
869	Feed	203.3	173.6	149.7	167.7	207.4
	Milk	50.5	48.3	46.9	44.9	48.4
	Excreta	160.5	128.4	105.4	120.1	142.4
	Balance	−7.7	−3.1	−2.6	+2.7	+16.6
884	Feed	205.4	175.3	148.7	138.8	208.5
	Milk	49.0	43.7	40.2	40.4	40.2
	Excreta	155.8	132.7	103.1	101.0	155.2
	Balance	+0.6	−1.1	+5.4	−2.6	+13.1

Note: Excreta, in this computation, includes urine, feces and brushings (shed hair and scurf).

TABLE 5

Relation of protein intake to production and requirements—daily averages

COW NUMBER	PERIOD NUMBER	AVERAGE WEIGHT OF COW	FAT CONTENT OF MILK	AVERAGE DAILY MILK PRODUCED	DIGESTIBLE CRUDE PROTEIN			RATIO SYNTHESIZED TO AVAILABLE NITROGEN†
					Actually fed	Computed maintenance requirement*	Available for production	
		kilos	*per cent*	*kilos*	*grams*	*grams*	*grams*	
869	I	370.6	5.19	8.422	799.4	222.4	577.0	1:2.16
	II	371.9	4.91	8.013	688.1	223.1	465.0	1.65
	III	372.5	5.18	7.495	547.5	223.5	324.0	1.17
	IV	374.3	5.26	7.488	651.9	224.6	427.3	1.44
	V	370.8	5.11	8.117	895.0	222.5	672.5	1.66
884	I	409.2	4.72	8.544	898.1	245.5	652.6	2.10
	II	410.6	5.14	7.565	666.3	246.4	419.9	1.58
	III	409.0	5.43	6.957	561.9	245.4	316.5	1.11
	IV	415.9	5.42	6.853	492.5	249.5	243.0	1.03
	V	406.3	5.60	6.891	940.0	243.8	696.7	2.09

* The maintenance requirement was assumed to be 0.6 kgm. per 1000 kgm. of live weight.

† The available nitrogen is computed by subtraction of the maintenance requirement from the digestible nitrogen of the ration. The synthesized nitrogen is the nitrogen of the milk plus positive and minus negative nitrogen balances.

These figures show that the milk-producing cow adheres to her natural rate of milk production with remarkable persistence, in spite of extensive change in the nitrogen intake.

Considering, first, cow 869, as the protein intake decreases from 203.3 to 173.6 and from 173.6 to 149.7 grams per day, 53.6 grams in all, the nitrogen in the excreta decreases almost an identical amount, 55.1 grams, while the loss from the body seemed actually to decrease, though these variations may be within the range of experimental error, and therefore not significant. At the same

TABLE 6

Daily utilization of nitrogen

COW NUMBER	PERIOD	DAYS OF LACTATION	NITROGEN INTAKE	COEFFICIENT OF DIGESTIBILITY	NITROGEN IN MILK	BODY GAIN OR LOSS IN NITROGEN	TOTAL NITROGEN SYNTHESIZED	NITROGEN SYNTHESIZED	AVAILABLE NITROGEN* SYNTHESIZED
			grams	*per cent*	*grams*	*grams*	*grams*	*per cent of intake*	*per cent*
869	I	142–148	203.28	62.94	50.45	−7.68	42.77	21.04	46.33
	II	156–162	173.56	63.46	48.29	−3.14	45.15	26.01	60.69
	III	170–176	149.73	58.52	46.88	−2.55	44.33	29.61	85.51
	IV	184–190	167.69	62.23	44.93	+2.13	47.56	28.36	69.56
	V	198–204	207.35	69.05	48.40	+16.53	64.93	31.31	60.34
884	I	58–64	205.41	69.96	49.04	+0.60	49.64	24.17	47.54
	II	72–78	175.30	60.81	43.92	−1.15	42.57	24.28	63.36
	III	86–92	148.70	60.46	40.16	+5.41	45.57	30.65	89.99
	IV	100–106	138.83	56.73	40.38	−2.56	37.82	27.24	97.27
	V	114–120	208.51	72.13	40.23	+13.10	53.33	25.58	47.84

* Available nitrogen is digestible nitrogen minus the maintenance requirement, and the utilized protein is the the protein of the milk plus positive and minus negative protein balances.

time the outgo of nitrogen in the milk decreased only from 50.5 to 46.9 grams per day.

This extensive decrease of outgo of nitrogen in the excreta signifies a decreased utilization of protein for fat and energy production, and, arithmetically at least, an increased efficiency in the utilization of the decreased intake, for milk production.

This observation is further illustrated by the figures in the right-hand column of table 6. These data (cow 869) make it seem that the utilization of protein available for milk production

had increased from 46.33 to 85.51 per cent as the proportion of the protein intake utilized for milk production was increased through the decrease in the utilization of protein for energy and fat production.

This cow (no. 869), having calved 142 days before the beginning of period I, was in the fifth and sixth months of lactation during Periods I, II, and III.

According to Hills[1] a cow normally decreases in milk production at a rate of one-tenth of the yield of the preceding month, for the first nine months of lactation. It seems likely, therefore, that the rate of decrease in milk production during periods I, II, III, was about normal, but the fact that the percentage of the total nitrogen of the rations synthesized (utilized for body gain or milk production) increased during these periods (see table 6) implies, at least, that the lowest rate of intake was closer to the rate of greatest efficiency than was the next higher. The failure of this cow to increase in milk production with the increase of nitrogen intake in period IV, however, though the increase was appreciable in period V, exhibits such a tendency for the milk production to lag behind the changes of rations as makes it uncertain whether the minimum milk production of period IV, really represents more clearly the feed of this period or of period III. These results, especially the relative constancy of milk production, suggest the necessity of very much longer periods if the results are to be used as indications of economy of production of milk.

With cow 884 the course of results was similar, in that, with progressive decrease in protein intake, in periods I, II, III, and IV, there was associated a progressive increase in efficiency of utilization of protein. With decrease of nitrogen intake there was appreciable decrease of nitrogen outgo in the milk, the minimum being reached in period III. The minimum nitrogen intake in period IV was reflected in decreased outgo in the excreta, and increased loss from the body, but did not cause further decrease in the nitrogen outgo of the milk. The extensive increase of nitro-

[1] Vermont Agric. Exp. Sta., Bul. 225, p. 146.

gen intake in period V, was reflected in prominent increase of nitrogen outgo in the excreta, and extensive increase in nitrogen retention, but on account of the lag of the milk production behind the ration changes, there was no improvement in milk production in this period.

With both cows the percentage utilization of available nitrogen decreased prominently coincident with the increase of protein intake, in periods IV and V with cow 869, and in period V with cow 884.

It is obvious, therefore, that the rate of intake characterized by most efficient use of protein would be reached only on such reduced protein intake that no protein (or at least the minimum amount possible) would be utilized for fat or energy production.

It will be noted that these data, which we have discussed, on efficiency of utilization of protein, have been based on the available protein, that is, the digestible protein in excess of the maintenance requirement.

More significant figures, from a practical point of view, would be those representing rate of efficiency of utilization of protein, based on the total protein intake.

Such data are set forth in the second column from the right in table 6, but these particular data are of such nature, on account of the lag of changes in milk production behind changes in protein intake, that it is impossible to say which of the past levels of intake is responsible for a given result.

All things considered, however, it appears that the rates of allowance of protein which prevailed in period III, with both cows, were most satisfactory, since in these cases there was neither extensive gain or loss of protein by the body, while high rates of efficiency in the production of milk prevailed, on the basis of both the available protein and the total protein intake.

The rate of nitrogen intake in these two cases was 148.70 to 149.73 grams total nitrogen. This supplied 1.11 to 1.17 times as much available nitrogen as was synthesized, and 1.027 to 1.028 times as much digestible true protein (in excess of the maintenance requirement) as was contained in the milk during the second week previous.

The more or less definite indication is, then, that after allowing for maintenance at a rate of 0.6 pound of apparently digestible crude protein per 1000 pounds live weight, the most efficient rate of crude protein intake for milk production, under the conditions of a metabolism investigation, with milk averaging 5.13 to 5.26 per cent fat content, is approximately 1.11 to 1.17 times the amount of the protein in the milk. The evidence in favor of these particular figures, however, is not conclusive, and more extensive data will doubtless modify them.

The practical significance of these data is indicated by a comparison of the protein intake of a cow fed in accord with these results, with the protein requirement of the same cow, according to Henry and Morrison's standard.

A 1000 pound cow, producing 40 pounds per day of milk containing 5 per cent of fat and 3.5 per cent of protein, would require, according to Henry and Morrison, 3.36 pounds of digestible crude protein per day. The same cow, fed in accord with the results of this experiment and on the particular rations used, would require 34.5 per cent less protein, or 2.20 pounds.

We do not mean to imply, however, that the most efficient rate of protein intake, as determined in a metabolism experiment, will cover all exigencies of practice. Requirements of practice must be determined under conditions of practice.

Our computations happen to have been based on an assumed maintenance allowance of 0.6 pound, instead of 0.7 pound of digestible crude protein according to Henry and Morrison, but this makes little difference in the result, since the assumption of a lower maintenance figure for protein arithmetically increases the allowance of available feed protein per pound of milk protein.

The most that can be concluded from the decreasing negative balances of nitrogen coincident with decreasing intake of nitrogen in periods I, II, III, if indeed the differences in these balances are significant, is that this decreasing rate of intake had an effect to induce more efficient utilization of the nitrogen of the ration. Having attained this habit of efficiency the cow was in condition to store nitrogen liberally with the increased intake in period V. The extensive improvement of the nitrogen balance in period V,

with slight increase in the nitrogen of the milk, is concordant with the common knowledge that after a decrease in milk production, in response to unfavorable conditions of feeding, it is very difficult, at any time in the same period of lactation, to bring the cow back to the normal rate of production.

A point of interest in connection with the coefficients of digestibility is that, in 7 cases out of 8, whenever the nitrogen intake was increased the coefficient of digestibility of protein was increased, and when the nitrogen intake was decreased the digestion coefficient likewise was decreased; which signifies that, with this ration, undigested nitrogen was more nearly a constant function of the animal than of the ration.

In this connection let us consider the fact that digestible protein, as determined in this experiment, was in reality, only *apparently* digestible, and that the figures for digestible protein were low by the amount of the undetermined metabolic nitrogen of the feces.

Were the figures for available protein low by the same amount? It seems not. Apparently the metabolic protein of the feces at least approaches a constant, related more definitely to the animal than to the feed, being represented, therefore, by a part of the maintenance allowance of protein. When the apparently digestible protein was decreased by the amount of the maintenance requirement, in reckoning the available protein, it was, in effect, corrected for the metabolic nitrogen of urine and feces together, since these comprise the maintenance quota.

SUMMARY

After allowing 0.6 pound apparently digestible crude protein (0.5 pound true protein) per 1000 pounds live weight for maintenance, an intake of crude protein equal to 1.25 times the milk protein of two weeks previous (true protein, 1.03 times the milk protein) caused a slight nitrogen loss with one cow, and a slight retention of nitrogen with the other. The intake, therefore, was close to the requirement.

In the same experimental periods the total synthesized protein (milk protein plus positive or minus negative protein balances)

was 0.85 to 0.90 of the amount of the crude protein available for increase (protein intake minus the maintenance requirement).

It is recognized that this rate of efficiency of production of milk, in relation to the protein intake, appliés less definitely to practice than to the conditions of these metabolism experiments.

Reduction of the protein intake from the larger to the smaller amounts fed had the effect to reduce the milk flow. Subsequent increase of protein intake caused a significant increase of milk production with the cow of more pronounced milk-giving tendency (no. 869), but no significant increase with the poorer cow (no. 884), while both cows responded to the increase of protein in the ration by considerable storage of nitrogen in the body.

With a low protein intake the utilization of protein for milk production was more efficient than with an intake of protein sufficient to permit of more extensive use for fat and energy production.

There is, with the cow, a prominent inclination to produce milk at an individual rate which is determined by inheritance. On account of the ability of the cow to deflect protein from energy production, and to withdraw protein from the tissues, and to use the same, in both cases, for milk production, the immediate effect of reduction of protein intake to reduce the production of milk is only partial in degree, the maximum effect being reached after a period which may extend to a number of weeks.

The apparent digestibility of protein by the cow increases prominently with increase in the protein intake, this effect apparently being due to metabolic protein being more nearly a body constant than a variable related directly to the feed.

THE EFFECT OF GESTATION UPON LACTATION IN THE DAIRY COW

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The nutrients required to develop the bovine fetus in the non-lactating dairy cow have been studied by Eckles (1) and Hill (2). Eckles, from a maintenance trial with 4 cows, concludes that the amount of nutrients necessary to develop the bovine fetus is so small that it cannot be measured by ordinary methods of experimentation. This, he thinks, is due to the fact that the amount of dry matter contained in the fetus and its accompanying fluid and membranes is very small,—the Jersey calf at birth being only equivalent to from 110 to 170 pounds of Jersey milk and the Holstein calf from 200 to 275 pounds of Holstein milk.

Hill, from a maintenance trial with 6 cows, found that fetal construction makes a relatively small draft upon the carbohydrate content of the ration, if one considers only the figures representing ultimate product and does not take cognizance of the draft made by the metabolic processes involved in fetal construction. The protein content of the ration, however, was somewhat more heavily drawn upon—to the extent of approximately 10 per cent of the gross digestible protein intake.

Since the publication of Eckles work with non-lactating cows, it has been quite generally inferred that gestation has no more effect upon milk production than that which may be accounted for by the dry matter content of the fetus.

The object of this paper is to report the results of a study to determine the effect of gestation upon the lactating dairy cow especially as it affects the rate of decline and total milk secreted. One method of attack was to select two groups consisting of animals from the Advanced Register of Guernsey Cattle. Included in the first group were all cows that were bred during the third and fourth months of lactation whereas only farrow

cows were selected for the second group. The average monthly milk production of the non-pregnant and pregnant cows was then determined by means of correlation tables. The results presented in figure 1 and table 1 show that during the first five months of lactation the farrow and the pregnant cows decline in

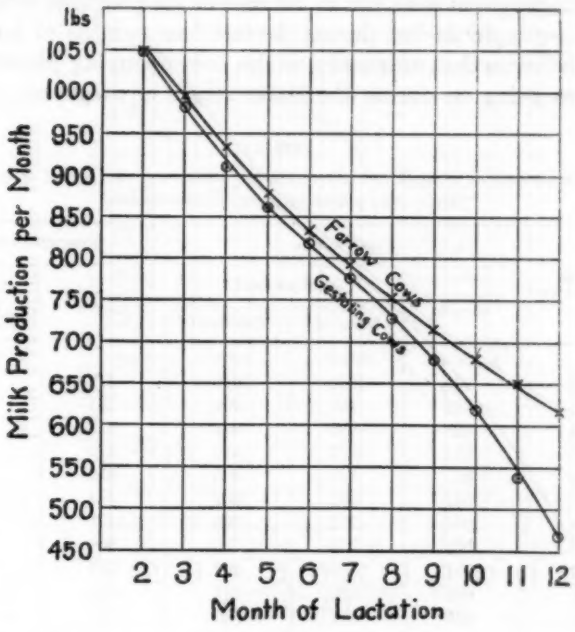

FIG. 1. THE AVERAGE MONTHLY MILK PRODUCTION OF NON-PREGNANT AND PREGNANT COWS

During the first five months of pregnancy both groups of cows decline in milk production in a similar manner. After the fifth month and until the end of the twelfth month of lactation the pregnant cows decrease in their milk flow more rapidly.

milk production in a similar manner. After the fifth month and until the end of the twelfth month of lactation the pregnant cows decrease in milk flow more rapidly. It was pointed out in a previous paper (3) that there is a law governing the decline of milk secretion with the advance of the period of lactation of cows

under favorable conditions of feeding and management. This law may be expressed as follows: Each month's production after the second month is a constant percentage of the preceding month's production (94.77 per cent in the case of the cows under consideration). This law holds true to a remarkable degree with the non-pregnant cows but in the case of the pregnant cows, there is a more rapid decline during the last four months of lactation. This indicates that pregnancy or the accompanying physiological changes going on during the latter stages of pregnancy cause a

TABLE 1

The relative decline of milk secretion with the advance of the period of lactation of farrow and gestating cows (Guernsey breed)

MONTH OF LACTATION	FARROW COWS			GESTATING COWS	
	Number of animals	Yield per month		Number of animals	Yield per month (observed)
		Observed	Calculated		
		pounds	*pounds*		*pounds*
2	920	1052	1049	373	1052
3	912	998	994	374	983
4	923	938	942	373	911
5	914	879	874	372	862
6	917	833	846	372	819
7	912	792	802	374	776
8	904	752	760	371	728
9	905	715	720	369	679
10	906	676	682	369	618
11	852	650	641	358	538
12	653	617	613	283	469

greater decrease in the rate of milk secretion than that due entirely to the advance of the period of lactation. The total decrease in the data studied amounted to over 480 pounds of milk.

A second method of study consisted in keeping the stage of lactation constant and varying the stage of gestation. This was accomplished by grouping cows for the twelfth, eleventh, tenth and eighth months of lactation according to the time after breeding. Table 2 presents the complete data. Figure 2 pic-

tures the effect of the stage of gestation for the eighth and twelfth months of lactation. This data shows a rapid decline in milk secretion after the fifth month of gestation.

The effect of pregnancy on yearly fat production is shown in table 3. It will be noted that the decline of fat production is greatest with cows pregnant two-hundred days or more.

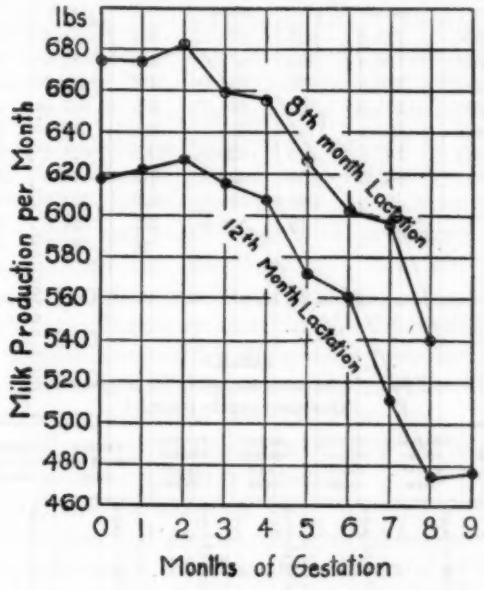

FIG. 2. THE EFFECT OF THE STAGE OF GESTATION WHEN THE PERIOD OF LACTATION IS CONSTANT

After the fifth month of gestation there is a rapid decline in milk secretion

When all age classes are combined there is a decrease of 40 pounds of fat between the cows pregnant not to exceed fifty days as compared to cows pregnant over two-hundred and fifty days. This amounts to a reduction of 800 pounds of 5 per cent milk.

The data presented indicate that gestation is the cause of a reduction of milk amounting to between 480 and 800 pounds

TABLE 2

The effect of the stage of gestation on the milk flow

MONTH OF GESTATION	EIGHTH MONTH OF LACTATION		TENTH MONTH OF LACTATION		ELEVENTH MONTH OF LACTATION		TWELFTH MONTH OF LACTATION	
	Number of cows	Milk yield per month	Number of cows	Milk yield per month	Number of cows	Milk yield per month	Number of cows	Milk yield per month
		pounds		*pounds*		*pounds*		*pounds*
0	906	752.8	907	676.2	854	651.4	654	616.8
1	887	736.4	393	673.9	315	682.9	276	621.9
2	1113	740.8	616	681.0	413	649.7	307	626.8
3	959	615.6	890	657.7	611	647.6	399	615.5
4	667	707.1	1133	655.1	869	616.0	593	626.6
5	319	707.8	975	626.9	1099	625.5	861	570.7
6	19	647.2	659	602.3	942	575.0	1085	562.2
7			294	595.9	620	539.8	909	508.4
8			18	536.6	272	524.7	563	471.7
9					14	527.1	199	474.1
10							11	561.8

TABLE 3

Effect of pregnancy on yearly fat production

(Guernsey yearly records)

DAYS PREGNANT	MATURE COWS		SENIOR FOUR-YEAR-OLDS		JUNIOR FOUR-YEAR-OLDS		SENIOR THREE-YEAR-OLDS		JUNIOR THREE-YEAR-OLDS		SENIOR TWO-YEAR-OLDS		JUNIOR TWO-YEAR-OLDS		ALL CLASSES COMBINED	
	Number of cows	Fat	Number of cows	Fat	Number of cows	Fat	Number of cows	Fat	Number of cows	Fat	Number of cows	Fat	Number of cows	Fat	Number of cows	Fat
		lbs.		*lbs.*		*lbs.*		*lbs.*		*lbs.*		*lbs.*		*lbs.*		*lbs.*
0-50	398	544.37	71	519.02	99	503.99	96	469.23	117	438.35	127	420.65	309	403.08	1,217	474.70
50-100	325	543.89	57	516.18	57	504.90	74	505.84	91	452.80	127	456.31	237	422.99	968	487.40
100-150	502	528.87	99	515.42	102	497.12	139	481.97	149	453.18	166	425.46	433	410.59	1,590	471.79
150-200	868	522.40	166	508.42	231	531.50	265	481.77	247	448.91	360	430.79	734	405.15	2,881	471.02
200-250	764	503.11	172	472.07	218	470.76	224	449.05	256	425.18	348	413.31	693	392.45	2,705	445.63
250-300	563	488.91	144	468.65	175	450.92	189	437.78	226	414.79	227	400.71	436	374.53	1,980	434.90
300-up	15	420.66	4	454.58	4	464.58	2	332.37	9	364.43	10	360.31	11	347.42	55	386.81
Total	3,435		713		886		989		1,125		1,365		2,843		11,356	

Note: This table includes all A.R. records from 1 to 9800 inclusive, and re-entries.

during the latter part of the lactation period. In order to interpret this data, it is necessary to have in mind the physiological changes that take place in the maternal organism during pregnancy.

With the onset of pregnancy, the dairy cow must not only provide the several nutrients for the production of milk but she must also provide the protein and energy necessary for building up and maintaining the developing fetus. During the early stages of pregnancy the embryo is so small in comparison to the weight of the mother that the nutrients required are insignificant. After the fourth or fifth month, however, the fetus has developed sufficiently to require an appreciable amount of nutrients for growth and maintenance. It has been shown by Bar (4) and Hoffstrom (5) that the nitrogen requirement is greatly increased during the eighth and ninth months of pregnancy. Magnus-Levy (6) and Carpenter and Murlin (7) have also shown the increased energy metabolism of pregnancy.

The drafts for nutrients required by the developing fetus may be in part compensated for by the greater retention of nitrogen during the latter stages of pregnancy (8). The metabolism may also be lowered by decreased activity of the dam. Armsby (9) has shown that metabolism decreases 30 to 40 per cent while the animal is at rest as compared to standing.

With a pregnant non-lactating dairy cow on maintenance the lowered metabolism and greater nitrogen retention might easily provide the nutrients for fetal maintenance and growth. On the other hand the nutrients available in the blood of the pregnant lactating dairy cow during the latter months of gestation must of necessity be divided between the needs of the fetus and the mammary gland.

It is believed that the reduction in the milk flow of the lactating dairy cow gives a better picture of the nutrients required to develop the bovine fetus than does the dry matter content of the fetus expressed in pounds of milk.

SUMMARY

Data is presented showing that the effect of pregnancy becomes apparent in a reduced rate of milk secretion when during lactation the period of pregnancy exceeds about five months. The total reduction may amount to from 480 to 800 pounds of milk if cows are bred during the early months of lactation. The data indicates that this reduction of milk flow is caused in part at least by the demand of the fetus for nutrients to support its life processes.

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MEASURING QUALITY IN ICE CREAM

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Uniform good quality ice cream must be one of the biggest assets in the continued expansion of the ice cream industry. What are the factors that make up quality in ice cream? The butter and cheese industry solved these questions sometime ago and a uniform system of grades and standards have been developed. So far no such grades and standards have been developed in the ice cream industry. Different score cards and other systems of measuring quality have been suggested from time to time, but none of these have become standardized. In view of the fact that ice cream is now included in the Educational Students Dairy Products Judging Contest at the Eastern States Exposition, and that serious consideration is being given towards including ice cream in the National Contest, it seems very desirable to establish some uniform system of measuring the quality of ice cream. It is with this idea in mind and in the hope of opening up a thorough discussion on the subject that the writers suggest a score card and a system of grades and standards. According to this score card, the factors that make up quality in ice cream are: Flavor, body and texture; bacteria color and package. The score card measures these quality factors by assigning to each a certain value which is as follows:

	per cent
Flavor	50
Body and texture	25
Bacteria	20
Package and color	5

Obviously, it is very seldom, if ever, that a sample of ice cream, butter or cheese, is given a perfect score of 100. No one actually knows what perfection is and some allowance must be made for this. In general a sample receiving a score of 90 per cent or above may be considered excellent, while a score of 80 to 90 would be representative of a good quality of ice cream. A score card or yard stick for measuring quality similar to the above, has now been used for two years at the Eastern States Dairy Products Judging Contests and also at the Educational scorings at the Massachusetts and Connecticut Agricultural Colleges. At each of these educational scorings, about thirty-five commercial samples from all over New England were received. At these occasions the score card has proven its practicability and value in measuring quality factors in ice cream, provided a uniform system of grades and standards can be worked out. To start the ball rolling and open up an opportunity for exchange of ideas, the following plan is suggested:

FLAVOR OR PALATABILITY

The quality of the flavor of ice cream may be classified from the standpoint of palatability under four general groups:

1. Highly pleasing and desirable: Flavors rating 45 to 50 points.
2. Desirable flavors: Flavors rating 40 to 44.9 points.
3. Objectionable flavors: Flavors rating 35 to 39.9 points.
4. Foreign (off) flavors: Flavors rating 25 to 34.9 points.

1. Highly pleasing and desirable flavors: Rating 45 to 50 points

Ice cream that is especially fresh, clean, sweet and well blended in flavor, having the proper degree of sweetness and flavoring and having a certain creaminess or richness in flavor characteristic of the pleasing flavor and aroma of fresh sweet cream, shall receive a rating of 45 to 50 points.

Descriptive terms: Fresh, clean, creamy, well blended.

2. Desirable flavors: Rating 40 to 44.9 points

Ice cream that is fresh, clean, creamy and sweet in flavor, but high or low in sweetness or flavoring material, shall be given a rating of 40 to 44.9.

Descriptive terms: Too sweet, lacking sweetness, too high flavoring, lacking flavoring.

3. Objectionable flavors: Rating 35 to 39.9 points

This class includes ice cream that is free from foreign, (off) flavors but shows objectionable flavors, such as old cream, old butter, bitter, cooked, condensed or powdered milk, gelatin or unnatural flavoring or unnatural flavoring such as pronounced glucose. Such ice cream shall receive a rating for flavor of between 35 and 39.9 points.

Descriptive terms: Old cream, old butter, old egg butter, cooked condensed milk, powdered milk, gelatin, unnatural flavoring, unrecognizable.

4. Foreign (off) flavors: Maximum rating 25 to 34.9 points

These include flavors, ordinarily termed foreign flavors (off) flavors which are distinctly disagreeable to the taste.

Ice cream showing salty, rancid, garlic, gasoline, disinfectant, unclean utensils or any other foreign (off) flavor distinctly disagreeable to the taste, shall be given a score of 25 to 34.9 points.

Descriptive terms: Salty, rancid, garlic, gasoline, disinfectant, unclean utensils, unrecognizable.

Ice cream with pronounced sour or other flavors bad enough to make it unsalable, shall be score 0 on flavor.

Note: Ice cream is never scored perfect in flavor, as no one knows what perfection is and 2 to 4 points leeway must be allowed. A score of within 2 to 4 points of perfect may therefore be considered excellent.

BODY AND TEXTURE

Class I: Rating 23 to 25

Ice cream receiving the rating of 23 to 25 must be firm, smooth and velvety in body and texture.

Descriptive terms: Firm, smooth, velvety.

Class II: Rating 20 to 22.9

Ice cream that is slightly fluffy, crumbly, icy, coarse, buttery, weak i. e. (no resistance), or soggy shall receive a rating of 20 to 22.9.

Descriptive terms: Fluffy, crumbly, icy, coarse, buttery, weak, soggy.

Class III: Rating 15 to 19.9

Ice cream that is sandy, pronounced soggy, buttery, icy, coarse, crumbly, weak, gelatin lumps, shall receive a rating of 15 to 19.9.

Descriptive terms: Sandy, soggy, crumbly, buttery, icy, coarse, weak, gelatin lumps.

PACKAGE AND COLOR

A. The suggested standard color for vanilla ice cream is the color of Guernsey or Jersey cream during the month of June or July with allowance for deeper shades of color when eggs are used in the mix. However the different markets vary greatly regarding the degree of color desired in ice cream. In the case of vanilla ice cream these requirements vary from almost white to a deep egg yellow:

In order to meet these requirements for color in ice cream the following shall be used as a basis of rating on color:

1. Ice cream in order to receive the full rating of 5 points must be free from specks, unnatural or uneven colors.

2. Ice cream showing dirt specks, unnatural colors or uneven colors shall be cut not exceeding 2 points according to the degree of the defect.

Descriptive terms: Dirt specks, unnatural, uneven.

B. *Package:* Ice cream receiving the full rating of 5 points must be neatly and solidly packed in clean, non-rusty cans and tubs, the cans being provided with parchment paper circles over the top.

Ice cream packed in unclean, rusty cans, or not provided with parchment circles shall be cut not exceeding 2 points according to the degree of the defect.

Descriptive terms: Unclean, rusty cans, no parchment.

With this exposition before you the following are some of the many questions that might be raised and discussed:

1. Is it wise to have a score card based on 100 points as perfect and considering only flavor, body and texture; and color and package for student contest work and another so-called commercial card considering not only the above items but bacteria as well?

In our opinion one complete score card for ice cream is enough. The need of an ice cream score card for students' judging work is very acute. In these contests students score ice cream on flavor, body and texture and color and package. It seems that there is need for a score card in the commercial field especially in educational scoring work. Such a score card undoubtedly should consider a measure of how the ice cream has been produced and handled. While the number of points that should be allotted to flavor, body and texture, and color and package together with a system of grades and standards for same are the most pressing things that need to be decided, there seems to be no good reason why bacteria should not be considered on the same score card. The essential thing to decide is the number of points to be allowed for each item on the score card and then adopt some system of grades as a trial until such time as further experience warrants a change.

2. Should body and texture be considered separately and given separate scores?

The suggestion has been made that body and texture are two different things and that they should be separated. We feel it is so difficult to draw the line on what is meant by body and what by texture that it would lead to confusion to separate them.

In a recent survey of college diary departments 12 are in favor of scoring body and texture together while only 3 are opposed and 3 non-committal.

3. In the score card suggested are the points apportioned correctly among the different items? Are items mentioned that should not be considered or are there items not mentioned that should be considered?

It seems advisable to allow 5 points for color and package. These are of relatively minor importance but certainly ice cream in a rusty or dirty container or ice cream of very unnatural color should not receive a perfect score.

It is doubtful if it can be argued that any kind of bacteria even the acid formers are beneficial in ice cream. If this is true ice cream with high bacteria count should not get as high a score as ice cream of low bacteria count. There are those who seem to feel that not enough is known about the bacteriology of ice cream to warrant its consideration on the score card. As the writers see it it is simply a question as to whether our bacteriologists know how to accurately sample ice cream and make an accurate bacteria test on the sample.

A few years ago about the same proposition confronted us in the case of market milk. Bacteria counts were considered unreliable. Would not including an allowance for bacteria on the score card help materially to stimulate research along the line of reliability of bacteria counts for ice cream. It is apparent that including bacteria count on the milk score card helped materially to stimulate investigation on standard methods of bacterial analysis for milk.

With regard to grades and standard for bacteria it will require considerable amount of experimental work, as a large number of bacteria counts made according to an approved method on a number of samples of ice cream are essential in deciding this point.

Baer of Oklahoma, and Olsen of Kansas have scored a large number of samples of ice cream on which bacteria counts have been made. In their work, samples showing 20,000 or less cubic centimeters have been given a perfect score of 20 points. The

following system of grades that we are suggesting does not differ very materially from the one used by Baer and Olsen. For 20,000 bacteria or less per cubic centimeter allow 20 points. Deduct ½ point for each 10,000 until 100,000 is reached, then deduct 1 point for each 25,000 until 200,000 is reached, after which deduct 2 points for each 50,000 until 500,000 is reached after which the score shall be 0.

The remaining question is, should more weight be given to flavor and less to body and texture. It is true that most of the large plants have a better control on body and texture than is possible for flavor and most of the ice cream from the large plants is perfect, or nearly so, in body and texture. However, the large number of commercial samples submitted to our educational scorings last winter show all sorts of body defects and convinces us that the smaller plants, especially, have not solved the problem of turning out ice cream of uniformly good body and texture. The consumer of ice cream will put up with a flavor that at best might be termed only fair, while coarse, icy or buttery ice cream will draw complaint at once. The writers of course feel that more weight should be given to flavor than body and texture, the above statements are made simply to argue the point that 25 points are not much less than should be allowed for body and texture.

4. Are the flavors properly classified and the cuts allowed for each group what they should be? Are there other off flavors that should be included in any of the classifications?

The matter of the number of points to cut for any defect does not seem so important as some of the previous questions. The important thing is to have some standard to follow and then have everybody stick to it. We have set our lowest flavor score on any ice cream that can be considered salable, from the standpoint of flavor, at 25 points. Ice cream of such poor flavor as to obviously make it unsalable is score 0 on flavor. This seems much better than allowing a range of from 0 to 25 points for the fourth class of flavors as it does away with the element of guess work to a large degree. To illustrate, a sample might be slightly salty but not bad enough to really class it as unsalable. If a free range of from 0 to 25 points was allowed for this defect the

judge might score it 10 while the student might score it 20. One guess might be as good as the other. Following our suggestion both judge and student would know the sample must score 25 to 34.9 points. This scheme does not solve the problem of differences in judgment of individuals as to what constitutes a flavor bad enough to make ice cream unsalable nor does there seem any way of solving this problem. However the matter is not serious as most ice cream is good enough to eat and if a sample is really bad it is likely to be so bad as to leave no doubt in the minds of any one as to its salability.

5. Are body and texture defects properly classified? Are there other defects that should be included?

It is not likely that ice cream will have a sufficiently poor body and texture to make it unsalable hence to avoid too wide a range of cuts for class 3 defects 15 points is considered the lowest possible score on body.

6. Should color receive any consideration on the score card and is the maximum cut of 2 points too large or too small?

It is felt that a fairly wide range should be allowed in scoring color of ice cream. The maximum cut of 2 points is intended to apply only to extreme cases where the color is very unnatural for the flavor with which it is used.

7. Some may criticize this card because it does not seem to consider fat and total solids or food value. The writers have been guided by what seems to them to be a wise suggestion coming from two well known ice cream authorities. The suggestion is, let fat and solids be governed by the state standard in the state in which it is made. Ice cream submitted for scoring would, of course, be tested for fat and total solids and the report sent to the manufacturer with the score scard. Ice cream that was below the state standard would be thrown out of any contest as it would not be legally called ice cream. In states having low standards for butterfat, if ice cream was made down close to the standard, it would be shown up on body and texture and flavor, unless by chance the solid not fat content was well reenforced, in which case, the ice cream should not be cut for lacking in food value. In general, there are no state total solid standards. Fat standards

differ so widely in different states that if fat and solids was given its allotment of points on the score card, we never could nationally reach an agreement as to what per cent of fat and solids constitutes perfection, and hence a base below which deductions would be made.

It is also a question in our minds if ice cream from a food value standpoint does not resemble cheese and butter more closely than it does milk. No direct consideration of food value is given on the butter and cheese score cards. Results of our educational scoring indicate that extreme variations in ice cream composition, especially total solids, is not the common thing. A variation of 2 to 4 per cent even though it might not show up in body and texture or flavor, is probably not at all serious from the standpoint of food value of ice cream.

The argument of simplicity, i.e., making the score card as simple as possible and doing away with "ornamentation" items is an important one and one that we have endeavored to bear in mind in making these suggestions.

SOME FACTORS AFFECTING THE KEEPING QUALITY OF WHOLE MILK POWDERS[1]

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It is generally known that whole milk powders of the past have not been endowed with the good keeping quality of skimmilk powder. The reason for this difference is the presence of butterfat in large amounts in the whole milk powder. These powders contain on the average from 26 to 29 per cent fat. The fat is subject to deterioration which may render the powders unsalable when this deterioration reaches a point where the flavor and odor are affected.

There are two different types of deterioration of fat which are noticeable in milk powders, namely, one associated with oxidation of the fat, producing tallowiness, and one associated with hydrolytic decomposition resulting in the liberation of butyric and other volatile acids. The fat affected by hydrolytic deterioration is rightly termed rancid.

Other off flavors may occur in whole milk powders which are also common in skimmilk powders. Decomposition such as staleness, mustiness, and storage flavors are not necessarily associated with butterfat. These defects are not powder defects but rather defects due to age, package, storage temperature, and time stored.

Earlier whole milk powders deteriorated in a very short time. Present day whole milk powders also occasionally deteriorate quickly. The writers have encountered typical cases of rancidity in powders which were less than five weeks old. Again,

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powders made by the same company have kept many months without serious defects. The quality of the fresh milk and the treatment of the milk prior to powdering have a decided effect upon the keeping quality of the finished product. Where the liquid milk is subjected to high temperatures of pasteurization (175° to 180°F.) little danger from rancidity need be expected. The lipase enzyme, which may be termed the cause of rancidity of butterfat, is rendered inactive at this temperature.

Tallowiness of the butterfat in milk powders is due to oxidation of the fat. Air, especially hot air, is a prominent factor in producing this decomposition. Earlier investigators (1) found that powders made by the drum process exhibited superior keeping qualities to powders made by the spray process. The writers (2) made note of the same conditions, but the drum-made powder studied was made from partly skimmed milk and contained but one-half as much fat as the spray-made powder. The writers expressed the opinion that the more rapid development of tallowiness in spray-made powders may be due to the peculiar structure of the powder grains. It was found that many, and in some cases each individual spray-made powder grain contained an air cell, thus exposing more of the fat to air. The onset of tallowiness was also found to be in proportion to the size of the air cell. No lipase activity or rancidity was noticed in the drum-made powder. The Storch test made on the drum powders studied showed that the fresh milk had been heated to at least 172°F.

PLAN OF EXPERIMENT

It was the purpose of this experiment to make a study of some of the factors affecting the keeping quality of certain whole milk powders and to compare the keeping quality of powders made by the various processes. Three types of powders were studied—one type (Klim) representing the pressure spray system known as the Merrell-Soule System, another type (Creamon) representing the centrifugal spray system controlled by the Dick Patents, and Creamora A representing the drum system and made by the Dry Milk Company of New York.

The factors studied were as follows:

1. The effect of increasing the moisture content of the powders on the keeping quality.
2. The effect of type of containers on the keeping quality.
3. The effect of storage temperature on the keeping quality.
4. The effect of time in storage on the keeping quality.

The samples were stored at three temperatures, namely, 4°C. (refrigerator), 20°C. (room), and 37°C. (incubator).

Scoring of the samples took place after they had been in storage three, six, nine, and twelve months. A sufficient number of samples was stored to permit the opening of a new sample at each scoring. In all 216 samples were used in the experiment and scored according to flavor and odor. No attempt was made to place a numerical score on the samples, but a complete set of notes was kept of the types of deterioration and the degree of decomposition noted.

The moisture content of the powders before and after exposing to damp air is shown in table 1. The moisture was increased by placing the powders in flat pans and exposing them for several hours at room temperature to an atmosphere nearly saturated with moisture. The samples were then packed into 2-ounce opaque glass jars. It required 39 grams of Klim, 20 grams each of Creamora A and Creamon to fill the jars with moderate packing. These weights indicate that Klim powder either consisted of smaller individual particles or contained a smaller air cell within the particles.

It is possible that deteriorations due to the treatment received by these powders in this experiment should not be attributed solely to the increased moisture content but partly to the exposure to moist air, inasmuch as the total moisture content of the exposed powders was not excessively high.

The deteriorations observed in table 2 show the deleterious effect of moisture and oxidation. It will be noticed that all of the samples stored at room temperature for three months became either off-flavored or discolored. Creamon powder exhibited the most pronounced tallowiness, followed by Creamora A. At six months all showed evidence of deterioration.

TABLE 1

The effect of exposing powders for three hours in an atmosphere having a humidity of 70 per cent

POWDER	ORIGINAL MOISTURE	MOISTURE CONTENT AFTER EXPOSURE
	per cent	*per cent*
Creamon	2.98	4.31
Klim	2.57	4.60
Creamora A	2.56	4.56

TABLE 2

The influence of increased moisture on the keeping quality of the powders studied

TIME STORED	20°C.	4°C.	37°C.
	Creamon powder		
months			
3	Very tallowy; unfit for use	Tallowy but not as bad as the 20° sample	Very tallowy, discolored and hard
6	Flavor stale	Stale, flat	Very tallowy, discolored and hard
9	Stale and tallowy	Stale, tallowy	Very tallowy, discolored and hard
12	Tallowy, hard	Stale, hard	Very tallowy, discolored and hard
	Klim		
3	Yellow color. Flavor good	Flavor good	Very tallowy, discolored and hard
6	Odor good; flavor slightly off	Odor dead, flavor flat	Very tallowy, discolored and hard
9	Stale and hard	Flat, though slightly stale	Very tallowy, discolored and hard
12	Tallowy and hard	Tallowy and hard	Very tallowy, discolored and hard
	Creamora A		
3	Very slightly tallowy	Good	Very tallowy, discolored and hard
6	Slightly tallowy	Odor of ice box	Very tallowy, discolored and hard
9	Stale, not usable	Flat	Very tallowy, discolored and hard
12	Stale	Tallowy	Very tallowy, discolored and hard

Samples from the same powders stored at lower temperatures showed slightly better keeping quality except in case of Creamon powder. After three months time all showed evidence of deterioration.

Deteriorations were more pronounced in the samples stored at 37°C. in the incubator than at either of the other temperatures. All of these samples became hard, yellow, tallowy, and utterly useless for any purpose. The deterioration in every sample had proceeded to the limit in three months time. No distinction could be made between the extent of the deterioration of the different powders. The higher temperature of the incubator greatly favored and accelerated the decomposition due to the higher moisture.

EFFECT OF TYPE OF CONTAINERS ON KEEPING QUALITY

To note the influence of containers on the keeping quality of whole milk powders several types of containers were employed. Small opaque glass jars with metal screw tops were used as well as "Sealright" paper containers, a plain paste board container, and "Doubletite" tin containers, both plain and "lacquered." The lacquered tin containers were made by coating the inside of the "Doubletite" containers with shellac to keep the powders from coming in contact with the metal.

THE KEEPING QUALITIES OF POWDERS STORED IN OPAQUE GLASS JARS

The opaque glass jars were used as check containers for the other experiments because of the freedom of glass from catalyzers and metal. The keeping quality of the powders stored in these containers is shown in table 3.

All powders kept well up to three months except the samples held at 37°C. These became hard, discolored, stale, and tallowy.

Slight off flavors were observed in the samples after six months in storage at 20°C. The degree of deterioration was slight, however.

The samples held for nine months and one year respectively, showed pronounced deterioration and were in general not usable or salable.

TABLE 3

The keeping quality of whole milk powder stored in opaque glass jars

TIME STORED	20°C.	4°C.	37°C.
		Creamon powder	
months			
3	Good	Good	Very tallowy, discolored (yellow) hard
6	Flavor slightly bitter, off	Slightly stale	Very tallowy, discolored (yellow) hard
9	Stale, not salable	Stale, tallowy	Very tallowy, discolored (yellow) hard
12	Tallowy, hardened	Flavor musty, stale; less soluble than that kept in tins	Very tallowy, discolored (yellow) hard
		Klim	
3	Good	Good	Very tallowy, discolored and hard
6	Very slightly off	Odor of ice box. Flavor good	Very tallowy, discolored and hard
9	Stale, hard	Slightly off.	Very tallowy, discolored and hard
12	Tallowy, hard	Stale, bad flavor (not as soluble as that in tins)	Very tallowy, discolored and hard
		Creamora A	
3	Good	Good	Very tallowy, discolored and hard
6	Odor good; flavor slightly dead	Storage odor	Very tallowy, discolored and hard
9	Slightly tallowy	Stale, musty	Very tallowy, discolored and hard
12	Flat, stale	Flat flavor (not as soluble as that in tins)	Very tallowy, discolored and hard

In general it may be said that this type of container was not suitable for storing whole milk powder, since it was not airtight. To prevent the entrance of air when using this type of container the covers should be sealed on with melted paraffine.

THE INFLUENCE OF "SEALRIGHT" CONTAINERS

Table 4 shows the effect of the "Sealright" paper containers on the keeping quality of the various powders. The Creamon and

TABLE 4

The influence of "Sealright" paper containers on the keeping qualities of whole milk powder

TIME STORED	20°C.	4°C.	37°C.
		Creamon	
months			
3	Good	Odor off, slight moldy flavor	Very tallowy, caked hard (yellow)
6	Good	Odor dead; flavor stale	Very tallowy, caked hard (yellow)
9	Stale, tallowy	Ice box odor, stale	Very tallowy, caked hard (yellow)
12	Slightly tallowy and stale	Flat, storage flavor; odor gone	Very tallowy, caked hard (yellow)
		Klim	
3	Good	Flavor, odor good; slight change in physical structure	Hard, very rancid; green mold present
6	Good	Storage flavor, flat	Very tallowy, hard and brown
9	Slightly tallowy	Flat, unsalable	Very tallowy, hard and brown
12	Stale, individual particles hard	Musty	Very tallowy, hard and brown
		Creamora A	
3	Slightly tallowy	Musty flavor	Brown and tallowy but not as hard as Klim
6	Odor of stale pastry	Odor of ice box; flavor stale	Brown and tallowy but not as hard as Klim
9	Slightly tallowy	Flat, unsalable	Brown and tallowy but not as hard as Klim
12	Stale, individual particles hard	Musty flavor; odor gone	Brown and tallowy but not as hard as Klim

Klim powders kept exceedingly well at the end of six months at room temperature. Creamora A showed deterioration at the first examination after three months in storage. The deterio-

ration was characterized by slight tallowiness and at six months by staleness.

"Sealright" cans are evidently too porous to permit their use in damp places such as refrigerators, where the moisture content is usually high. None of the powders kept well in "Sealright" containers when held under this condition. The original flavor and odor of the powder were lost and musty and storage flavors had appeared at the time of the first examination. Room temperature storage gave considerably better results than either refrigerator temperature (where humidity was high) or incubator temperature (37°C.).

INFLUENCE OF PLAIN PASTE BOARD CONTAINERS

The results with the plain paste board containers are shown in table 5. These containers do not have as thick walls as "Sealright" containers, otherwise there is little difference in general appearance. Practically the same conditions were noted in the use of these containers as in the use of "Sealright" containers, for the first six months. Creamon and Klim powders did not deteriorate appreciably at room temperature. Creamora A showed signs of deterioration at the first examination. These containers are also too porous to permit their use in refrigerators of humid places at either high or low temperatures. Fat leaked through the sides of these containers containing Creamora A powder stored at 20° and at 37°C. The deterioration of fat in these samples was extremely noticeable. The cause of the leaky fat will be discussed under "the comparison of keeping quality of the various powders."

The characteristic musty and storage flavors and odors were noticeable in powders stored at 4°C. The musty odors disappeared in some instances at the end of one year.

INFLUENCE OF PLAIN TIN ("DOUBLETITE") CONTAINERS ON KEEPING QUALITY

The plain tin container gave excellent results, as shown in table 6. Very little air, if any, could gain access to the powder

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months			
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9	Stale, tallowy	Ice box odor, stale	Very tallowy, caked hard (yellow)
12	Slightly tallowy and stale	Flat, storage flavor; odor gone	Very tallowy, caked hard (yellow)
		Klim	
3	Good	Flavor, odor good; slight change in physical structure	Hard, very rancid; green mold present
6	Good	Storage flavor, flat	Very tallowy, hard and brown
9	Slightly tallowy	Flat, unsalable	Very tallowy, hard and brown
12	Stale, individual particles hard	Musty	Very tallowy, hard and brown
		Creamora A	
3	Slightly tallowy	Musty flavor	Brown and tallowy but not as hard as Klim
6	Odor of stale pastry	Odor of ice box; flavor stale	Brown and tallowy but not as hard as Klim
9	Slightly tallowy	Flat, unsalable	Brown and tallowy but not as hard as Klim
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INFLUENCE OF PLAIN TIN ("DOUBLETITE") CONTAINERS ON KEEPING QUALITY

The plain tin container gave excellent results, as shown in table 6. Very little air, if any, could gain access to the powder

because of the tight fitting cover. The Creamon and Creamora A powders after three months at 20°C. were scored off slightly on odor, and at six months a trifle on flavor. After six months to one year there was little criticism to make of any powders stored at

TABLE 5

Influence of paste board containers on keeping quality of whole milk powders

TIME STORED	20°C.	4°C.	37°C.
		Creamon	
months			
3	Good	Good	Badly oxidized; hard, yellow, tallowy
6	Good	Dead odor; off flavor	Badly oxidized; hard, yellow, tallowy
9		Dead odor, stale	Badly oxidized; hard, yellow, tallowy
12	Stale; particles hard	Flavor flat, storage odor	Badly oxidized; hard, yellow, tallowy
		Klim	
3	Good	Odor of paper; flavor good	Hard, yellow, tallowy
6	Flavor not as good as "Sealright"	Flavor dead	Hard, yellow, tallowy
9	Stale, hard	Good	Hard, yellow, tallowy
12	Stale, particles hard	(lost)	Hard, yellow, tallowy
		Creamora A	
3	Moldy (yellow mold) Slight butter flavor	Slightly stale; musty flavor	Brown but not very hard. tallowy
6	Flat	Musty odor; flavor stale but not as bad as "Sealright"	Yellow, hard, tallowy
9	Stale, unsalable	Musty flavor	Yellow, hard, tallowy
12	Stale, particles hard	Flat	Yellow, hard, tallowy

room temperature except the Creamora A sample which showed a slight staleness after 9 months and tallowiness after one year in storage.

The samples stored at 4°C. came out after one year's time in salable condition. They had lost somewhat their original fresh

flavors and odors during that time, but none exhibited any serious defects.

TABLE 6

Influence of plain tin "Doubletite" containers on keeping quality of whole milk powders

TIME STORED	20°C.	4°C.	37°C.
		Creamon	
months			
3	Very slightly off in odor; flavor good	Good	Tallowy but not baked hard nor discolored as in other containers
6	Flavor slightly off	Odor dead; flavor stale	Tallowy and slightly brown in color
9	Odor and flavor good (particles hard)	Odor and flavor good (particles hard)	Tallowy but not baked hard nor discolored as in other containers
12	Flavor good (particles hard)	Slightly flat but good	Odor and flavor bad; color white
		Klim	
3	Good	Good	Color normal; not hard; flavor off
6	Odor slightly stale; flavor good	Odor good; flavor good	Not discolored; odor slightly tallowy; flavor slightly tallowy
9	Good	Salable	Not brown nor hard; fair condition
12	Flavor good (particles hard)	Odor gone; flavor good; salable	Color normal; odor and flavor bad
		Creamora A	
3	Slightly stale flavor; odor good	Good	Not colored but slightly tallowy
6	Odor good; flavor dead	Good	Odor slightly tallowy; not yellow or hard; flavor slightly tallowy
9	Stale	Fairly good	Odor slightly tallowy; not yellow or hard; flavor slightly tallowy
12	Tallowy	Lost	Color white; odor and flavor bad

An outstanding characteristic of the plain tin "Doubletite" container was the protection offered the powders from heat and

oxidation. All powders in the other containers thus far studied, when stored at 37°C., became hard, tallowy, stale, and highly discolored. The color of some powders was deep brown. With only one exception the powders stored in this container at high temperatures came out at the end of a year without hardness or change in color. The color of all but one was as good as those stored at low temperatures. The flavor was affected in most cases, however.

From the data of this experiment the value of "Doubletite" or other perfectly tight tin containers for use in the tropics can be appreciated. No containers mentioned previously gave satisfaction under tropical conditions. The excellent keeping quality of powders stored in this tin container was undoubtedly due to the absolute exclusion of air and moisture.

INFLUENCE OF "LACQUERED" TIN CONTAINERS ON KEEPING QUALITY

There are tin containers on the market which are coated on the inside with a very thin coat of lacquer. Being unable to obtain any lacquered "Doubletite" containers a thin coat of shellac was applied to the inside of some plain "Doubletite" containers similar to the ones used in the previous experiment. The shellac was permitted to dry thoroughly before the powder was placed in the tins.

The shellac afforded no improvement over the plain tin containers as shown by the data in table 7. In fact the shellac had a detrimental influence. Up to six months in storage at room and low temperatures there was not much difference between plain tin and the shellacked tins, but after six months some of the powders in the "Shellacked" containers developed a cheesy odor. This was noticeable in many instances and the powder so affected was rendered unsalable and unfit for human use.

The same protection against hardness, extreme tallowiness, and discoloration was afforded by the shellac lined tin as was noted when the plain tins were used. With one exception all powders examined after being in storage for one year at 37°C. were free from color change. This exception as well as the exception in the

TABLE 7

The influence of tin (lacquered) containers on the keeping quality of whole milk powders

TIME STORED	20°C.	4°C.	37°C.
	Creamon		
months			
3	Slightly off	Good	Cheesy bad odor, not yellow, nor hard
6	Cheesy odor, evidently protein decomposition	Flavor slightly cheesy; odor dead	Tallowy, not hard nor discolored
9	Cheesy odor; cheesy flavor	Cheesy odor and flavor	Not hard nor yellow but very cheesy odor
12	Cheesy, bad	Slightly rancid, but fair	Brown but not hard
	Klim		
3	Good	Good	Off, not hard nor discolored
6	Odor good	Flavor nearly gone	Not colored; flavor and odor slightly stale
9	Stale, probably due to lacquer	Good but odor of lacquer	Slightly stale; not hard nor brown
12	Stale, off-flavored	Slightly stale but good; more soluble than others	Color good; odor and flavor bad
	Creamora A		
3	Off odor and flavor cheesy	Good	Not colored, but cheesy; slightly tallowy
6	Odor good; flavor dead	Odor good; flavor good	Flavor and odor slightly tallowy; not yellow nor hard
9	Off in flavor	Off, due to lacquer	Color white; flavor and odor bad
12	Slightly cheesy probably due to lacquer	Slight storage flavor but not as bad as paper containers; more soluble than in paper containers	Color white; odor and flavor bad

plain tin container was found in the Creamon powder. This powder ordinarily contained more air within each particle than either of the other powders studied. It may have been possible that the covers admitted some air in the cases where exceptions were noted.

THE INFLUENCE OF STORAGE TEMPERATURE ON KEEPING QUALITY OF WHOLE MILK POWDER

It was evident from the start that an extremely high temperature (37°C.), such as was experienced in this experiment, was very deleterious to keeping quality. This was augmented by the presence of air. When air could be excluded, as in case of powders packed in "Doubletite" tins or packed in vacuum, practically no browning or discoloration was experienced. The vacuum tests consisted of samples of each powder packed in porcelain jars without covers. These jars of powders were then placed in a desiccator upon which a 29-inch vacuum was drawn. The vacuum samples were discontinued after six months since no browning had been noticed. The tin containers were the only ones used which could be recommended for tropical use. Yet in these tins pronounced tallowiness was noticed in many instances after three months due to its heat and the air within the package. The other containers were useless at this temperature.

Many manufacturers have placed emphasis on the injurious effects of refrigeration on keeping quality of whole milk powders. This was borne out clearly in all cases except when powders were stored in airtight containers. Paper containers and others through which air might enter cause the powders to lose their fresh flavors and odors and become flat in some instances and in other instances to assume musty or storage odors and flavors. Tin containers kept the powders in good condition. In several instances salable and sweet powders were in evidence after a year's storage.

Not only did the powders lose their flavor when stored in paper containers at this temperature but the solubility of the powder was reduced considerably. This was especially true of the Cream-

ora A powder. It appeared to be tough and dough-like when attempts were made to dissolve it in the mouth.

Excellent results were obtained from storing powders in airtight containers, at 20°C. Creamora A powder stored in pasteboard containers leaked fat after three months' storage and became off flavored. Creamon and Klim kept better in paper containers when stored at room temperatures than they did when stored at low temperatures.

INFLUENCE OF TIME

The time factor was clearly shown to be a prominent factor as was expected. The longer the time stored the greater were the deteriorations in most cases. There were cases where a slight decomposition was recorded after six months in storage which were not noticed after nine months or one year. Occasionally certain off flavors seemed to volatilize in time, but this was not generally noticed. Time of storage, when coupled with the other factors, bore a vital relation to the solubility of the powders, as well as to the keeping quality.

COMPARISON OF THE KEEPING QUALITY OF THE POWDERS STUDIED

A comparison of the keeping quality of powders made by different processes would be meaningless without first calling attention to the source of milk from which powders are derived. To make a comparison of the effect of the processes of manufacture on the keeping quality, the milk from which the powder is derived should be from the same general source. This condition did not exist in this experiment. The milk entering the Creamora A (drum) and the Klim (pressure-spray) was produced in the eastern states from different sources, while the milk entering the Creamon powder (centrifugal spray) was produced in one locality in the middle west. A poor keeping powder is not necessarily indicative of poor raw milk supply. The sources of milk, the process of manufacture, time and conditions of storage are all contributing factors. All of the samples of powders were stored under iden-

tical conditions in this experiment so the contributing factors in the comparison of the various powders must be limited to the source of milk and the process of manufacture.

Early investigators and the authors have made statements which intimated that drum-made powder had superior keeping qualities over spray-made whole milk powders. The previous observations made by the authors were made on Dryco, a partly skimmed powder. The evidence from the present experiment showed that Creamora A (drum) did not exhibit keeping qualities superior to Klim (spray). In fact it was plainly inferior at the end of nine months and one year. The keeping quality of Creamon (spray) and Creamora A (drum) were not far different. In some cases Creamora A was slow to exhibit defects but in time the defects were plainly evident. The only conditions under which the Creamora A powder excelled in keeping quality were when it was stored at low temperature and in airtight containers. Creamon exhibited the poorest keeping quality when the moisture was increased. This was probably due to the high air content of this powder, since the increase in moisture was not as great in that powder as in the others studied.

In plain tins the Klim powder excelled in keeping quality. In these containers outside air was excluded so the only air present was the air within the particle in the form of an air cell, or the air surrounding the particles. As already noted, the particles of Klim powder permitted closer packing than the other powders.

Inferior keeping quality of Creamora A powder in paper containers was evident in most cases. It was plainly seen that the fat leaked from the powder through the pores of the plain pasteboard container to the outside when stored at 20° and 37°C., and a high degree of deterioration usually accompanied this occurrence. This leaking of fat was very likely due to the high degree of heat used in drying this powder. This high heat tends to decrease the stability of the hydrophilic colloids which are necessary to keep the fat dispersed.

The spray powders changed somewhat in physical condition during the experiment. All powders in the moisture experiment were nearly insoluble at the time of the last scoring. Samples

held in paper containers, especially those at low temperatures, decreased in solubility. Whenever pronounced tallowy flavors were evident the solubility was low.

Minute hard particles, similar to crystals, were noticed in almost all the samples at the expiration of the experiment. This condition suggested the presence of crystals of milk sugar, although microscopic examination revealed nothing unusual in the appearance of the individual particles. There was a noticeable decrease in solubility of the individual particles when observed under the microscope. Fresh spray powder disintegrates rapidly when a drop of water is placed on the particle on a slide. Water dropped on the powder on a slide at the close of the experiment showed very slow disintengration of the particle in most instances. Mild solutions of NaOH caused rapid disintegration of the individual particles, leaving the air cells which are found in the spray powders free to float around in the liquid. A few of the air cells broke, but the number which broke did not compare with the number which broke when the fresh powder dissolved in water. The surface tension of the air cell apparently increased greatly with age.

Powders which were subjected to the high temperature during storage and which had become brown and hard were insoluble in water and exhibited but very little disintegration when a drop of alkaline solution was dropped on a slide containing the powder grains.

The rapidity with which powder grains disintegrate in cool water and in weak alkaline solutions may be used as a qualitative index of their solubility.

SUMMARY

A study of the keeping quality of 216 samples representing three types of whole milk powders is described as follows:

Powders whose moisture content was increased by exposing the powders to moist air exhibited very inferior keeping qualities. Oxidation of the fat, giving rise to a tallowy odor, was the cause of deterioration.

Containers in which the powders were stored greatly influenced the keeping quality. Containers permitting the entrance of air proved to be useless for long time storage. Deterioration was very pronounced in the samples stored in these containers, the extent of deterioration was usually more marked in case of the Creamora and Creamon A powders. Klim powder is not exposed to as much air as either of the other powders in the package. It has smaller individual powder grains which permit closer packing than Creamora A and Creamon, and the air cell when present within the powder grain is much smaller than that of the other spray powder, Creamon.

Superior keeping quality was observed in samples of powders stored in tin "Doubletite" containers. These containers provided for absolute exclusion of outside air and moisture. In some cases samples were practically unchanged after a year in storage. Protection against discoloration, due to high storage temperature, was afforded when this type of container was used. This was not the case when other containers were used. Lacquered tin containers afforded no better protection than the unlacquered. In most instances the keeping quality was inferior to powders stored in the unlacquered tins.

Pasteboard containers proved to be unsatisfactory, since air and moisture gained access to the powder. Tallowy and musty flavors were the main deteriorations observed.

The temperature at which the powders were stored proved to be an important factor. Not a great deal of difference was observed between powders stored at 4° and 20°C., but a great difference was observed when powders were stored at 37°C. Most of these powders deteriorated very rapidly at this temperature and became very hard and discolored. The powders stored in the tin containers "Doubletite" did not become discolored, and the deterioration was not so pronounced as in cases where other containers were used.

The influence of the time of storage depends on factors such as type of containers used and temperature of storage. Powders stored in opaque glass containers with screw tops and those in paste board containers showed signs of deterioration after three

months in storage, while some powders stored in tin "Doubletite" containers showed scarcely no deterioration after one year in storage at 4° and 20°C. All powders stored at 37°C. showed pronounced deterioration at the time the first examination was made, or after three months in storage.

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THE METABOLISM OF CALCIUM, MAGNESIUM, PHOSPHORUS AND SULFUR IN DAIRY COWS FED HIGH AND LOW PROTEIN RATIONS

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For a number of years this Station has been studying the effects of wide and narrow rations on dairy cows. In 1921 and 1922 for the purpose of obtaining a more intimate knowledge of the utilization of the rations, digestion trials were conducted on four of the cows used in this study. As these animals had been restricted to winter rations all their lives, it seemed especially desirable that we should take advantage of the opportunity thus afforded and include in this work a determination of the balances of at least four of the more important mineral elements. The results of which are here reported, together with the nitrogen balances.

Forbes and associates (1) in an extensive series of metabolism experiments, have brought out the fact that the ability of the cow to utilize the inorganic constituents of the ration is much more limited than her ability to utilize the organic constituents. Their results particularly emphasize a limited ability of the liberally milking cow to utilize the calcium and phosphorus of the ration. The calcium balances were always negative with a milk production exceeding 10 pounds per day, while the phosphorus balances were usually so. Losses of these elements occurred regardless of an apparently sufficient supply of them in the rations, which included such roughages as clover and alfalfa hays. Larger losses of calcium were encountered during the feeding of timothy hay than during the feeding of clover and alfalfa hays.

Standing somewhat contradictory to these results are those of Hart, Steenbock and Hoppert (2), who observed positive calcium and phosphorus balances on three liberally milking cows. In these experiments alfalfa hay that had been cured under caps was fed as roughage. Replacing this alfalfa hay by green alfalfa seemed to even increase the retention of calcium and phosphorus. The suggestion is made that the process used in curing the hay was instrumental in preserving the "unknown factors affecting calcium assimilation." They stage that "in harmony with previous observations that green plant tissue contains more than dried plant tissue of some substance favoring calcium assimilation."

These same authors (3) have shown that milking goats are enabled to utilize more efficiently the calcium of the ration when the fresh green oat plant is fed in preference to oats straw; and that the curing of oat hay out of the direct sunlight aided in the retention of those qualities assisting calcium assimilation.

Later work by Hart, Steenbock, Hoppert and Bethke (4) has shown liberally milking cows to be losing calcium and phosphorus. In this case, alfalfa hay cured by four days exposure to the sun while in the windrow was fed. However, these losses were often slight and as the authors state, "could no doubt be maintained for a long time without serious results to the animal." When timothy hay was fed large losses of calcium and phosphorus were encountered. Adding steamed bone meal to the ration containing the timothy hay reduced these losses somewhat but did not make this ration on a par with that containing the alfalfa hay.

Meigs, Blatherwick and Cary (5), conclude from the results of metabolism experiments that the disturbance to the cow resulting from the separate collection of urine and feces as practiced in the metabolism experiments may interfere with the assimilation of phosphorus and nitrogen and more especially calcium. They point out that large calcium losses from the bodies of cows as reported in the various balance experiments are not to be explained on the basis of a wasting of the bones; because the losses of calcium and phosphorus have not been in

the same ratio as that in which these elements are found in the bones. Meigs (6) also points out the apparent impossibility of large losses of calcium as reported by Forbes.

TABLE 1

Data concerning cows used

	cow 111	cow 146	cow 154	cow 192
Breed	H.F.	H.F. (grade)	H.F.	H.F. (grade)
Date of birth	1/31/13	4/10/15	7/17/15	8/28/17
Previous lactations	5	3	3	1
1921				
Freshened prior to test	12/30/20	2/12/21	12/25/20	3/18/21
Live weight at start of test (pounds)	1273	955	1102	981
Day of lactation at start of test	195	153	200	117
Average daily milk production (pounds)	30.34	30.59	31.09	32.39
Type of ration, lactation and test	1:9	1:4	1:9	1:4
Month of gestation (test)	3	Not bred	3	1
1922				
Freshened prior to test	1/20/22	6/8/22	1/21/22	3/21/22
Live weight at start of test (pounds)	1330	1083	1135	1071
Day of lactation at start of test	175	44	181	111
Average daily milk production (pounds)	38.18	52.20	32.91	32.27
Type of ration, lactation and test	1:4	1:9	1:11	1:2
Month gestation (test)	Not bred	Not bred	1	Not bred

EXPERIMENTAL

Cows

Table 1 gives the essential data concerning the cows used in these experiments. They have been reared from weaning time on rations of the same type as those supplied to them in the 1921 balance trial. Their dams had also received rations of like character. The 4 cows used in this work have never tasted pasture grass. They have grown to maturity and have seemingly developed normally. The calves produced by them have

been normal. Although abortion has been more or less prevalent in the herd, kept in the same barn, this disease has never occurred among these 4 individuals. The average frequency of calving has been approximately every thirteen months. Two of them, nos. 111 and 154, are purebred Holstein-Friesian cows, while the other 2, nos. 146 and 192, are high-grades of the same breed. These animals were included in the group of 7 cows upon which mineral palatability tests were conducted by Forbes (7).

Although these cows were at their minimum live weight during the tests in both years, it could not be said of any of them that they were in a weakened, emaciated or unthrifty condition. Their appetites were keen and they entirely consumed the feed offered during the time covered in the data reported. Cow 192 in the 1922 experiment went off feed on the eighth day and was dropped from the experiment. However, after the administration of a physic and the withholding of two feeds, she was again able to consume a ration of the same type and amount as formerly. The data on this cow for the 1922 test only cover a period of seven days or that time during which she entirely consumed all her feed and seemed perfectly normal.

These cows had passed the period of maximum milk flow, but had not reached that stage in lactation of rapid decline. In the 1921 experiment the average daily milk production ranged from 30 to 32 pounds. In the 1922 experiment, cows 154 and 192 were producing approximately 32 pounds daily; while the daily production of cows 111 and 146 was 38 and 52 pounds, respectively. In the 1921 test, cow 146 was farrow; cow 192 was in the first month of gestation while cows 111 and 154 were in the third month. They were all farrow during the experiment of 1922 with the exception of cow 154, which had been bred one month previously.

Feeds

All feeds used in these tests were of the best quality, with the exception of the timothy hay in 1921, which had evidently been cut when quite mature. The clover hay fed in both experiments was of that year's crop, having been cut about one week pre-

vious to the preliminary feeding. This hay was cured in the sun for two days and was then spread out on the barn floor and allowed to dry thoroughly. However, it was in fit condition for storage in the mow when taken from the field. It was of choice quality and had retained remarkably well its original color. One point which we think worthy of mention is, that

TABLE 2

Composition of feeds—per cent (as weighed for rations), 1921

FEED	PHOSPHORUS	SULPHUR	CALCIUM	MAGNESIUM	NITROGEN
Clover hay	0.1825	0.1762	0.9736	0.3003	1.893
Timothy hay	0.0942	0.1196	0.2547	0.1166	0.646
Beet pulp	0.0600	0.2783	0.7070	0.3948	1.355
Corn	0.2174	0.1199	0.0144	0.1586	1.385
Wheat bran	1.3712	0.2137	0.0948	0.6674	2.575
Cotton seed meal	1.2241	0.4847	0.2110	0.6814	7.060
Oil meal	0.8863	0.3130	0.3292	0.5696	4.680
Water		0.0001	0.0066	0.0016	0.0002

TABLE 3

Composition of feeds—per cent (as weighed for rations), 1922

FEED	PHOSPHORUS	SULPHUR	CALCIUM	MAGNESIUM	NITROGEN
Clover hay	0.1738	0.1783	1.1136	0.3287	1.944
Timothy hay	0.1813	0.1536	0.2596	0.1067	1.035
Beet pulp	0.0702	0.2350	0.6734	0.3069	1.370
Corn	0.2137	0.1176	0.0109	0.1092	1.450
Wheat bran	1.5161	0.2188	0.1067	0.6010	2.250
Cotton seed meal	1.3851	0.4672	0.1837	0.7076	6.720
Oil meal	0.6995	0.3659	0.3322	0.5416	5.490
Gluten meal	0.5453	0.9430	0.0191	0.0400	10.560
Water		0.00005	0.0048	0.0017	0.00016

this hay had not been through the sweat of the mow. The corn gluten meal used in the 1922 trial was a specially prepared product and ran extremely high in protein. The corn was of a yellow pigmented variety and used in the rations in a finely ground state.

The feeds were mixed, sampled for chemical analysis, weighed and put in paper sacks before the beginning of the experiments.

Each was weighed and analyzed individually. The beet pulp was placed in a separate paper sack and fed mixed with three times its weight of water. The hays were cut into 6-inch lengths, weighed and sacked separately. The percentage composition of the feeds are given in tables 2 and 3. The analyses are here stated on the same moisture basis as that found to exist when the feeds were weighed for the rations.

Rations

Table 4 shows the rations used in these tests. These same type rations had been fed from the beginning of the lactation period,

TABLE 4

Daily rations used (pounds)

FEED	cow 111		cow 146		cow 154		cow 192	
	1911	1922	1921	1922	1921	1922	1921	1922
Clover hay	5.0	12.0	12.0	5.5	5.0	4.5	12.0	11.0
Timothy hay	5.0	2.4	2.4	5.5	5.0	6.75	2.4	
Beet pulp	8.25	6.0	1.8	8.25	8.25	10.95	1.8	2.75
Corn	6.0	3.6	2.4	8.25	6.0	6.75	2.4	
Wheat bran	3.0	3.6	2.4	2.75	3.0	2.25	2.4	3.30
Cotton seed meal	0.3	3.0	3.0	0.55	0.3		3.0	3.30
Oil meal, O. P.	0.3	3.0	3.0	0.55	0.3		3.0	3.30
Gluten meal		1.2						5.22
Nutritive ratio	1:9	1:4	1:4	1:9	1:9	1:11	1:4	1:2

and rations identical as to feeds and amounts for four weeks previous to the preliminary period. A mineral mixture consisting of steamed bone meal, precipitated calcium carbonate, flowers of sulfur and salt, had been fed for a period of eight months, ending forty-five days prior to the beginning of the 1921 trial. No mineral mixture has since been fed to these cows.

In 1921 period, cows 111 and 154 received the wide ration, the nutritive ratio of which was 1:9; and cows 146 and 192, the narrow ration, the nutritive ratio of which was 1:4. The wide ration cows each consumed the same amount of feed, which is also true of the narrow ration cows.

In the second trial, that of 1922, these cows received rations of unlike character and amounts. Cow 111, which had formerly received a wide ration (1:9) was given a narrow ration (1:4) cow 146 was changed from a narrow ration (1:4) to a wide ration (1:9). Cows 154 and 192 received rations of the same type as in the 1921 balance trial, only more extreme; the ration of cow 192 narrowed from 1:4 to 1:2. These changes had been made at the beginning of the lactation periods.

Salt was fed separately at the rate of 2 ounces per day and entirely consumed by all the cows. This amount hardly seemed adequate for cow 154 in the 1922 trial.

The water supplied the cows for drinking purposes was deep well water, but it was not from the same source both years. It was given to the cows in such amounts as they would drink, but a strict account was kept of the quantity consumed. Samples for chemical analysis were taken daily. This deep well or natural water was used in preference to distilled water, in order to maintain as nearly as possible the normal conditions under which these cows had been kept. In our opinion, it is no more essential to purify the water used in the rations than it is to purify the feeds, provided, of course, that the same care be taken in determining the intake of the elements contained therein.

Conduct of experiments

The tests were conducted in the same barn in which the cows were kept and in stalls in which they had previously spent a part of their lives. The stalls were big and roomy and afforded the cows sufficient liberty to lie down in comfort. The experimental day started at 8:00 a.m. The cows were weighed each morning as soon after 8:00 a.m. as was possible, before watering, but after milking and feeding. Milking, feeding and watering were each done twice daily; and in all respects an effort was made to adhere as closely as possible to the routine to which the animals had been accustomed.

Collecting, sampling, etc.

The methods used in collecting and sampling the milk and excreta were similar to those used in like experiments. The

daily samples were placed in cold storage and kept until the end of the experiment. They were then composited. For the 1921 trial 6 composite samples of milk, urine and feces were saved from the products of each cow; and for the 1922 trial, 3 composite samples were saved. The milk and urine samples were analyzed in their original condition; while the feces samples were air-dried and finely ground and then analyzed. Consequently all data for the amounts and composition of the feces here stated refer to the air-dried condition.

The 1921 experiment extended over a period of eighteen days, from July 15 to August 1.

The 1922 experiment extended over a period of twelve days, from July 22 to August 2, for all cows except cow 192.

Methods of analysis

Calcium. McCrudden method (Jour. Biol. Chem., 1911, x, 194). Titrating calcium oxalate precipitate with potassium permanganate.

Magnesium. McCrudden method (Jour. Biol. Chem., vii, 2).

Nitrogen. Kjeldahl-Gunning-Arnold method—Official.

Phosphorus. Official gravimetric method. Digesting sample with nitric and fuming nitric acids in the presence of sulphuric acid.

Sulfur. Modified Benedict method (Jour. Amer. Chem. Soc., xli, 10).

DISCUSSION

Calcium balances

Of the 8 calcium balances here reported, 4 are negative and 4 are positive. The 4 negative balances occurred with cows receiving the wide rations. These losses of calcium were less than 1 gram in 3 cases and in the fourth, the loss amounting to 3.6 grams daily, occurred with a milk production of 52 pounds per day. All of the narrow ration cows were found to be storing calcium. Three of these storages were approximately 4 grams and the fourth 8 grams. The plan of our experiment has not been such as to permit a definite answer explaining the cause

for this difference in calcium retention between the two groups of cows. But reasoning from the results derived from other experiments, we are able to offer a possible explanation.

Hart and associates (2) have shown the possibility of cows storing calcium when producing from 20 to 45 pounds of milk daily, when alfalfa hay which had been cured under caps was fed. When green alfalfa replaced the alfalfa hay, the storage of calcium was increased. These calcium storages when alfalfa hay, cured under caps, was fed seem to be contrary to later findings by the same authors (4), and also to the results of Forbes and associates (1). Hart and associates (2) suggest this difference in calcium assimilation has been due to the quality of the hay used. They ascribe to the alfalfa hay, cured under caps, some of the same powers influencing calcium assimilation as those proved to be present in the green alfalfa.

As previously mentioned, the clover hay used in both of our experiments was well cured fresh hay having been cut about one week prior to the preliminary feeding. It had retained remarkably well its original color and had not been subjected to overcuring in the sun. This hay was common to all the rations but used in much larger amounts in the narrow rations. In the light of the former work, just referred to, it may be reasoned that the storage of calcium by the narrow ration cows was due to the larger amounts of clover hay received by them, ascribing to this hay the presence of some organic factor assisting calcium assimilation. We merely offer this as a suggestion. There are other points to be taken into consideration in this connection, namely, the larger amounts of calcium and phosphorus contained in the narrow rations and that this type of ration furnished the greater part of its calcium in a leguminous roughage, the quality of the hay not being considered. Owing to the nature of our work we find it impossible to prove from the data the cause of this difference in calcium retention. But the balances here determined show that the narrow rations favored a greater calcium assimilation, than the wide rations; and that in accordance with the work of Hart and associates (2) it is possible for liberally milking cows to store calcium.

TABLE 5

Average daily balances of minerals and nitrogen (grams)

Cow 111, 1921, N.R. 1:9

	AMOUNT	PHOSPHORUS	SULFUR	CALCIUM	MAGNESIUM	NITROGEN
Intake						
Feed	12,632	35.98	24.38	56.74	39.34	196.97
Water	60,262		0.06	3.98	0.96	0.12
Total intake		35.98	24.44	60.72	40.30	197.09
Outgo						
Milk	13,763	11.86	3.20	13.30	1.63	56.16
Urine	13,394*	0.25	9.86	3.02	9.91	55.79
Feces	4,022	27.40	12.07	45.15	28.49	85.77
Total outgo		39.51	25.13	61.47	40.03	197.72
Balance		3.53	−0.69	−0.75	+0.27	−0.63

* Cubic centimeters.

TABLE 6

Average daily balances of minerals and nitrogen (grams)

Cow 154, 1921, N.R. 1:9

	AMOUNT	PHOSPHORUS	SULFUR	CALCIUM	MAGNESIUM	NITROGEN
Intake						
Feed	12,632	35.98	24.38	56.74	39.34	196.97
Water	61,232		0.06	4.04	0.98	0.12
Total intake		35.98	24.44	60.78	40.32	197.09
Outgo						
Milk	14,101	11.68	3.59	13.17	1.63	60.28
Urine	12,505*	0.16	8.37	1.62	7.68	38.98
Feces	4,368	24.94	12.65	46.17	31.90	89.45
Total outgo		36.78	24.61	60.96	41.21	188.71
Balance		−0.80	−0.17	−0.18	−0.89	+8.38

* Cubic centimeters.

TABLE 7

Average daily balances of minerals and nitrogen (grams)

Cow 146, 1921, N.R. 1:4

	AMOUNT	PHOSPHORUS	SULFUR	CALCIUM	MAGNESIUM	NITROGEN
Intake						
Feed	12,244	57.45	27.65	70.08	46.85	323.91
Water	69.283		0.07	4.57	1.10	0.14
Total intake		57.45	27.72	74.65	47.95	324.05
Outgo						
Milk	13,874	11.43	3.38	14.38	1.35	57.02
Urine	25,392*	0.24	12.12	1.52	7.53	163.94
Feces	4,439	50.34	14.12	54.58	39.07	95.99
Total outgo		62.01	29.62	70.48	47.95	316.95
Balance		−4.56	−1.90	+4.17	0	+7.10

* Cubic centimeters.

TABLE 8

Average daily balances of minerals and nitrogen (grams)

Cow 192, 1921, N.R. 1:4

	AMOUNT	PHOSPHORUS	SULFUR	CALCIUM	MAGNESIUM	NITROGEN
Intake						
Feed	12,244	57.45	27.65	70.08	46.85	323.91
Water	69.283		0.06	4.10	1.00	0.13
Total intake		57.45	27.71	74.18	47.85	324.04
Outgo						
Milk	14,693	12.61	3.68	13.15	1.59	62.92
Urine	15,368*	0.24	12.27	2.39	8.02	171.23
Feces	4,438	49.37	13.55	54.29	34.14	95.62
Total outgo		62.22	29.50	69.83	43.75	329.77
Balance		−4.77	−1.79	+4.35	+4.10	−5.73

* Cubic centimeters.

TABLE 9

Average daily balances of minerals and nitrogen (grams)

Cow 111, 1922, N.R. 1:4

	AMOUNT	PHOSPHORUS	SULFUR	CALCIUM	MAGNESIUM	NITROGEN
Intake						
Feed	15,785.4	72.93	39.74	90.82	56.21	438.45
Water	76,262.5		0.04	3.66	1.30	0.12
Total intake		72.93	39.78	94.48	57.51	438.57
Outgo						
Milk	17,314	13.41	4.48	18.13	1.97	78.62
Urine	21,464*	0.14	16.24	3.66	10.64	214.29
Feces	5,040	54.84	17.41	63.96	41.33	126.97
Total outgo		68.39	38.13	85.75	53.94	419.88
Balance		+4.54	+1.65	+8.73	+3.57	+18.69

* Cubic centimeters.

TABLE 10

Average daily balances of minerals and nitrogen (grams)

Cow 154, 1922, N.R. 1:11

	AMOUNT	PHOSPHORUS	SULFUR	CALCIUM	MAGNESIUM	NITROGEN
Intake						
Feed	14,134	34.50	25.82	65.50	34.65	206.50
Water	65,082		0.03	3.12	1.11	0.10
Total intake		34.50	25.85	68.62	35.76	206.60
Outgo						
Milk	14,925	12.15	4.05	15.06	1.67	64.68
Urine	16,004*	0.14	6.92	2.39	7.76	35.02
Feces	4,598	21.55	12.91	51.24	27.03	91.05
Total outgo		33.84	23.88	68.69	36.46	190.75
Balance		+0.66	+1.97	−0.07	−0.70	+15.85

* Cubic centimeters.

TABLE 11

Average daily balances of minerals and nitrogen (grams)

Cow 146, 1922, N.R. 1:4

	AMOUNT	PHOSPHORUS	SULFUR	CALCIUM	MAGNESIUM	NITROGEN
Intake						
Feed	14,220.2	43.60	26.28	62.49	37.06	238.37
Water	68,900		0.03	3.31	1.17	0.11
Total intake		43.60	26.31	65.80	38.23	238.48
Outgo						
Milk	23,678	18.83	5.89	27.28	2.89	95.03
Urine	11,778*	0.14	6.44	0.65	7.0	43.52
Feces	4,430	25.15	12.78	41.46	26.06	96.56
Total outgo		44.12	25.11	69.39	35.95	235.11
Balance		−0.52	+1.20	−3.59	+2.28	+3.37

* Cubic centimeters.

TABLE 12

Average daily balances of minerals and nitrogen (grams)

Cow 192, 1922, N.R. 1:2

	AMOUNT	PHOSPHORUS	SULFUR	CALCIUM	MAGNESIUM	NITROGEN
Intake						
Feed	13,095.2	76.35	49.91	73.73	48.88	580.57
Water	77,156		0.04	3.70	1.31	0.12
Total intake		76.35	49.95	77.43	50.19	580.69
Outgo						
Milk	14,636	11.28	3.84	14.84	1.86	66.80
Urine	34,632*	2.79	24.78	4.93	7.40	334.12
Feces	4,345	56.35	20.09	53.45	41.06	160.20
Total outgo		70.42	48.71	73.22	50.32	561.12
Balance		+5.93	+1.24	+4.21	−0.13	+19.57

* Cubic centimeter.

Phosphorus balances

In considering the balances for this element, it must be remembered that the work of Hart and associates (2) has shown that the assimilation of phosphorus, like that of calcium, may be affected by the quality of the hay. Here, again, our use of fresh clover hay may have had some effect on the balances. However, in the 1921 data, we see that phosphorus was lost by all the cows, those fed on the narrow ration losing slightly more. These conditions are reversed in the data for the 1922 work in which 3 of the 4 balances are positive, the 1 negative balance of 0.5 gram occurring with a high level of milk production. In this latter experiment the narrow ration cows were storing phosphorus in amounts exceeding 4 grams, while the storage for the 1 wide ration cow whose milk production permits a comparison, was less than 1 gram per day. Here, then, we have a slight indication that the narrow rations would permit a larger storage of phosphorus. We are at a loss to explain why the difference between the phosphorus balances of the two years should have existed. The feeding of mineral supplements, which had ended forty-five days prior to the 1921 test, may have had some influence over the balances of that year.

Magnesium balances

Magnesium losses are shown in 3 of the 8 balances; these have all been less than 1 gram per day and all have occurred with the storage of nitrogen. Of the 4 positive balances of magnesium, 2 have occurred with nitrogen losses and 2 with nitrogen storage. The greatest amount of magnesium stored was 4 grams. There is little difference between the storages or losses of this element on the two different types of rations. The outgo of magnesium in the urine from each individual cow has seemingly been little affected by a change in the ration.

Sulphur balances

The balances for this element in the experiment of 1921 were all negative, the narrow ration cows losing slightly greater amounts

than the wide ration cows. In the 1922 experiment, the data show that there was an apparent retention of sulphur by all the cows, the amounts retained in each case were similar. The gain or loss of this element never exceeded 2 grams. It is apparent that the balances for sulphur have not been greatly affected by the type of ration consumed by the cows.

Nitrogen balances

In contrast to the extreme difference in the nitrogen intakes with the two types of rations, no marked differences are seen in the balances for this element. Six of the 8 balances are positive, the average daily storage varying from 3 to 19 grams. Two losses are noted, one amounting to less than 1 gram, occurring with a low nitrogen intake; and the other approximating 5 grams, occurring with a high nitrogen intake.

SUMMARY OF DISCUSSION

Eight balances of calcium, magnesium, phosphorus, sulphur and nitrogen are reported. Four of these balances were determined on cows receiving high protein rations, and 4 on cows receiving low protein rations.

The cows were all producing liberal quantities of milk, although in most cases, they had passed the period of maximum production. They were also at or near their minimum live weight.

The mineral content of the narrow rations was higher, especially in phosphorus and calcium.

All the cows receiving the high protein rations were found to be storing calcium, while those receiving the low protein rations were found to be losing this element. It is suggested that this difference in calcium storage was due to the larger amounts of clover hay contained in the high protein rations. The clover hay used was fresh hay that had not been subjected to an excessive amount of bleaching in the direct sunlight. The data here presented show the possibility of calcium retention with liberal milk production.

In the 1921 experiment, the phosphorus balances for the two groups of cows were somewhat similar, losses being noted in all cases. The results of the 1922 experiment indicate that the narrow rations, here used, would permit a greater phosphorus retention than the wide rations.

The magnesium, sulphur and nitrogen balances of the high protein fed cows show no marked difference from the corresponding balances of the low protein fed cows.

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A QUANTITATIVE DETERMINATION OF THE AMMONIA, AMINO NITROGEN, LACTOSE, TOTAL ACID, AND VOLATILE ACID CONTENT OF COWS' MILK

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A quantitative determination of the ammonia, amino nitrogen, lactose, total acid, and volatile acid content of 27 samples of commercial milk obtained from Baltimore dairies has been made within the past year. As this milk was to be used in a later bacteriological investigation, it was sterilized by autoclaving before being subjected to chemical analysis.

AMMONIA

Shaffer (1903) published a modification of the vacuum distillation method of Boussingault (1850). Shaffer stated that, although Boussingault had found no decomposition on distilling urea solution in a vacuum with either lime, sodium carbonate or bicarbonate at 50°C., and had concluded that there was no decomposition in urine under the same conditions, there was a slight decomposition in some urines. To shorten the time of distillation to a point where this slight decomposition might be disregarded, methyl alcohol was added to the urine. This lowered the boiling point of the mixture so that a more rapid ebullition took place and all of the ammonia was driven off by the end of fifteen minutes. Shaffer found the use of sodium carbonate preferable to the use of other alkalies, for with sodium carbonate there was no foaming to render the operation difficult, there was less decomposition than with lime and no greater than with magnesia, and the expulsion of the ammonia was as rapid when liberated from ammonium salts as from a solution of free ammonia.

The method of vacuum distillation as adapted by Shaffer was as follows: To 50 cc. test material were added an excess (15 or 20 grams) of sodium chloride, about 50 cc. of methyl alcohol, and 1 gram of sodium carbonate. The flask containing this mixture was surrounded by a water bath at 50°C. By the use of a water pump the pressure was reduced until the liquid boiled and the ammonia was driven off into two wash bottles containing N/10 sulphuric acid. At the end of fifteen minutes all ammonia had been given off. The acid was now titrated with N/10 sodium hydroxide, using alizarin red as an indicator. Shaffer stated that this indicator is not affected by the presence of ammonium salts and is very little sensitive to carbonic acid.

Sherman (1905) stated that the Boussingault-Shaffer method for the determination of ammonia in urine had been studied by Berg (1904) with regard to its applicability to the much smaller amounts of ammonia which occur in milk. The following method was used for the determination of ammonia in milk. To 50 cc. of the sample were added 50 cc. of methyl alcohol, 10 grams of sodium chloride, and 0.5 gram of sodium carbonate. Sherman states that the sodium carbonate liberates the ammonia from its salts, and the sodium chloride diminishes the dissociation of the carbonate and thus prevents or retards the cleavage of ammonia from the nitrogenous organic compounds in the milk. If the sodium chloride is omitted in the distillation, a larger amount of ammonia is obtained. "For convenience," Sherman says, "the ammonia thus easily split off from organic matter by dilute sodium carbonate at 55° to 60°C. is called cleavage ammonia."

Harris (1919–1920) used Shaffer's modification of Boussingault's vacuum distillation method for determining ammonia in various media and bacterial cultures. Harris, however, omitted the use of sodium chloride and kept the temperature of the water surrounding the distilling flask at 50°C.

In the present investigations, sodium chloride was omitted in the vacuum distillation of milk and the water bath kept at 50°C. As the resulting figures for the ammonia content of the 27 samples of milk (see table 1) appeared too large when compared with the figures of Kendall, Day and Walker (1922), a control

TABLE 1
Sterile milk

	SAMPLE								
	I	II	III	IV	V	VI	VII	VIII	IX
†Nitrogen as ammonia	11.2	39.2	11.2	15.79	18.92	15.79	54.32	26.60	11.2
†Amino nitrogen (Wolf and Harris)		14.31		10.60	23.84	46.27	10.17	13.35	42.63
†Amino nitrogen (Denis and Minot)		2.33	1.88	2.55	3.07	3.12	1.80	2.03	2.79
‡Reducing substances	2.93	4.25	4.04	4.25	4.48	4.14	4.36	4.14	4.19
pH	6.6	6.6	6.6	6.5	6.6	6.6	6.6	6.5	6.6
§Total acidity (1:10 dilution)	2.2	1.2	1.6	1.2	1.6	1.8	1.2	1.6	1.6
§Volatile acids	1.0	1.0	1.0	0.6	1.0	1.0	0.7	1.0	1.0

	SAMPLE								
	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII
†Nitrogen as ammonia	38.04	25.59	32.76	17.36	17.36	18.87	32.48	46.59	26.32
†Amino nitrogen (Wolf and Harris)	33.2	28.40	24.09	21.85	28.10	29.42	31.73	24.03	25.04
†Amino nitrogen (Denis and Minot)	4.09	2.4	2.37	2.59	2.61	2.54	2.32	2.40	3.49
‡Reducing substances	4.36	3.67	3.94	3.94	3.36	4.48		4.25	4.09
pH	6.6	6.8	6.4	6.4	6.5	6.4	6.6	6.6	6.4
§Total acidity (1:10 dilution)	1.2	1.6	1.6	2.0	1.6	1.8	1.8	1.8	2.0
§Volatile acids	1.0	1.0	1.0	1.0	1.0	1.4	1.4	1.6	1.8

	SAMPLE								
	XIX	XX	XXI	XXII	XXIII	XXIV	XXV	XXVI	XXVII
†Nitrogen as ammonia	23.52	11.2	38.64	23.52	29.68	32.48	20.72	26.60	26.60
†Amino nitrogen (Wolf and Harris)	21.29		20.39	20.27	31.23	22.30	17.56	45.58	30.60
†Amino nitrogen (Denis and Minot)	2.30	2.43	3.29	3.94	3.06	3.37	2.10	2.50	2.10
‡Reducing substances	3.89	4.14	4.19	5.13	5.47	5.29	3.55	3.99	4.25
pH	6.5	6.6	6.6	6.4	6.6	6.4	6.4	6.4	6.4
§Total acidity (1:10 dilution)	2.2	1.8	2.0	2.8	3.2	2.6	2.0	2.0	3.2
§Volatile acids	1.6	1.6	1.2	1.6	1.6	1.6	1.4	1.2	2.0

† Milligrams per 100 cc. of the medium.
‡ Calculated as percentage of lactose.
§ Cubic centimeters of N/10 KOH required to neutralize 100 cc. of the medium.

analysis was made with one sample of milk to which sodium chloride was added. The analysis duplicated with the previous analysis in which sodium chloride was omitted. It was therefore indicated that the large ammonia figures obtained were not due to the omission of sodium chloride but to some other factor. Sherman (1905) says that "both the ammonia existing as such in milk, and the cleavage ammonia increased rapidly under conditions which favor the decomposition of proteids by bacteria or molds." Richmond (1914) says that the presence of ammonia in milk may be due to bacterial action. It is evident, therefore, that the amounts of ammonia present in milk would vary greatly, depending upon the age of the milk and the bacteria present. The commercial milk used throughout this study was analyzed at least thirty hours after milking.

AMINO NITROGEN

In the determination of amino nitrogen in milk, the Van Slyke method was used. Two methods of preparing the amino solution were used as a means of placing a check on the technique of the operation of the Van Slyke apparatus. Following the method described by Harris (1919–1920), the residue left in the distilling flask after the distillation of ammonia was acidified with acetic acid and filtered. The filtrate was then made up to 50 cc. and 1 cc. of this amino solution was used for the determination of amino nitrogen in the Van Slyke micro-apparatus. Duplicate solutions were prepared according to Harris' method and duplicate determinations were made of each solution. The largest percentage error accepted from the same solution, or from the average of the determinations from the two solutions, was 10 per cent.

The second method used was that devised by Denis and Minot (1919) for the determination of amino nitrogen in milk. Twenty cubic centimeters of milk were placed in a 200-cc. volumetric flask. To the medium were added 40 cc. of N/100 acetic acid, 10 cc. of 5 per cent copper acetate solution, and 60 cc. of distilled water. The flask was placed in a boiling water bath

for thirty minutes and at the end of that time 1 cc. of a 15 per cent solution of potassium oxalate was added. The mixture was cooled, brought to volume, and filtered through a dry filter paper. To the filtrate was now added 0.5 gram of powdered potassium oxalate and the solution allowed to stand for at least an hour before filtering. Fifty cubic centimeters of the final filtrate were evaporated on a water bath to 1 to 2 cc. and this concentrated amino solution was used for the determination of amino nitrogen by means of the Van Slyke apparatus. Duplicate solutions were made according to this method and duplicate determinations made of each solution. As in the solutions prepared by Harris' method, the largest percentage error accepted was 10 per cent.

On comparison of the results obtained from the determination of amino nitrogen from solutions prepared according to the method of Harris with results obtained by the method of Denis and Minot, it was observed that the actual amount of amino nitrogen in a sample of milk was much larger when determined from a solution prepared by the former method than when prepared according to the latter method.

When determined from solutions prepared by Harris' method, the amino nitrogen of sterilized milk varied from 10.17 to 46.27 mgm. per 100 cc. of the medium. The amounts of amino nitrogen in sterile milk, as determined from solution prepared by the method of Denis and Minot, ranged from 1.8 to 4.09 mgm. per 100 cc. of the medium. In table 1 are given the amounts of amino nitrogen in milligrams per 100 cc. of the medium for the 27 samples of sterile milk analyzed.

Several possible sources of error may be pointed out in Harris' method. Folin and Denis (1912) found that certain nitrogenous substances, such as creatine, asparagine, and tyrosine, when added to blood, could not be recovered quantitatively after precipitation with methyl alcohol. Greenwald (1915) concluded that alcohol precipitates some nitrogenous non-protein constituents of the blood, of which 25 to 50 per cent represents amino acid nitrogen as determined by Van Slyke's method. Bock (1916) found that amino acids added to the blood could not be recovered quantitatively after the use of methyl alcohol as a protein precipitant.

A second source of error is indicated by Van Slyke (1912). He states that it is essential that all the ethyl alcohol added to the medium before the ammonia determination should be driven off, for it decomposes the nitrous acid in the deaminizing vessel of the Van Slyke apparatus with the formation of large volumes of gases, which can be removed with permanganate only with difficulty and by the use of perfectly fresh permanganate solution.

A third source of error lies in the hydrolysis of the protein of the milk with an alkali. It is therefore evident that, while the amount of nitrogen in milk might be decreased by precipitation with methyl alcohol, the amount might also be increased by hydrolysis of the proteins during the removal of ammonia and by incomplete removal of the alcohol during this process. That there was a constant increase in the amino nitrogen of sterile milk when the amino solution was prepared by the method of Harris is shown in table 1.

LACTOSE

In determining the lactose content of milk, the method used was that devised by Folin and Denis (1918) for the determination of lactose in milk. The percentage of lactose in the 27 samples of milk analyzed ranged from 2.93 to 5.29 per cent.

HYDROGEN-ION CONCENTRATION

The hydrogen-ion concentration of sterile milk varied in the twenty-seven samples from 6.4 to 6.6 pH. A 1:10 dilution of milk was used in the determination of hydrogen-ion concentration. Clark (1921) states that a well-buffered solution may often be diluted without seriously altering the pH. "When dealing with complex solutions which are mixtures of very weakly dissociated acids and bases and their salts, and especially when the solution is already near neutrality, dilution has a very small effect on the pH. . . . . Differences which may be observed are quite as likely to be due to the changes in the protein and salt content."

TOTAL ACIDITY

The total acidity of sterilized milk was determined by titration of a 1:10 dilution with N/10 potassium hydroxide, using phenolphthalein as an indicator. From 1.2 to 3.2 cc. of N/10 potassium hydroxide were required to neutralize 100 cc. of the solution. This gave a total acidity of 12 to 32 cc. of the undiluted milk.

VOLATILE ACIDS

The presence of volatile acids in sterile milk was determined by the steam distillation method of Dyer (1916) as modified from that of Ducleaux (1900). One hundred cubic centimeters of milk were made acid to Congo red and steam distilled. The distillation was carried out at a uniform rate for each experiment and the same amount of distillate collected (500 cc.). Harris (1919–1920) stated that, except for acids of low volatility, such as formic acid, this method would yield from 90 to 95 per cent of the total acid present. The distillate was then titrated with N/10 potassium hydroxide, using phenolphthalein as an indicator. As the amounts of volatile acids in milk were very small, 1 cc. of pipettes were used for the titrations. Results were expressed as cubic centimeter of N/10 potassium hydroxide per 100 cc. of the medium.

In the identification of the volatile acids in milk Dyer's qualitative color tests were used. One hundred cubic centimeters of the distillate obtained from the steam distillation of the medium were neutralized with potassium hydroxide and concentrated to about 20 cc. Portions of this concentrated distillate were used for tests for the presence of formic, acetic, butyric, valeric, and caproic acid. The volatile content of the twenty-seven samples of milk analyzed ranged from an acidity requiring from 0.7 to 2.0 cc. of N/10 potassium hydroxide to neutralize 100 cc. of the medium. While these figures are much lower than those given by Wolf and Harris (1916–1917), they are closely comparable to the amount given by Bushnell (1922). The volatile acid content of milk may be expected to vary widely with the amount and kinds of bacteria present and with the age of the milk.

Acetic acid, butyric acid, and caproic acid were identified in the distillate of milk by means of Dyer's colorimetric tests.

A reduction of dilute solutions of potassium permanganate was observed in a number of instances. As this was one of the tests used by Rettger (1901) for the recognition of the volatile sulphide which he found to be given off when milk is heated above 85°C., a positive test could not be taken as proving the presence of formic acid in milk.

Meigs and March (1913) found a constituent of milk which formed a large part of the unknown alcohol soluble substances, and which gave a strong test for unoxidized sulphur. It seems possible that this substance is identical with that noted by Rettger.

A volatile sulphide which blackened lead acetate paper was found by the writer to be given off from all samples of acidified or unacidified milk when subjected to steam distillation. A heavy blackish deposit was formed within the Liebig condenser at the point of condensation of the vapor from the distilling milk. As this precipitate gave a positive test for mercury, it is suggested that the blackish substance may be a compound of mercury (volatilized from the steam generator) and the sulphide given off by the heated milk.

SUMMARY

The amino nitrogen content of the same sample of milk varied widely with the method of preparing the amino solution for use in the Van Slyke apparatus. Closely duplicating results were obtained from the same solution under the same conditions by the use of the Van Slyke micro-apparatus.

All samples of milk, when subjected to steam distillation, gave off a volatile sulphide.

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A CHEESE FACTORY TEST FOR CRITICAL DEGREES OF ACIDITY[1]

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Modern chemistry has provided a means for classifying indicators, which greatly facilitates the selection of suitable ones for any given purpose.

Colorimetric hydrogen ion determinations usually can not be made with milk because the casein present adsorbs the color. However, casein can be precipitated from milk by rennet, and the fresh whey is said to have the same hydrogen ion content as the milk. In the cheese factory, these facts find practical application. Cheese is commonly made by curdling milk with rennet, and the whey exuding from the curd carries with it lactic acid produced by the bacteria in the curd.

Swiss cheese makers usually begin their daily work with entirely sweet milk, and sometime during the process of manufacture lactic acid begins to be formed. The first appearance of 0.01 per cent of lactic acid in the whey, raising its acidity from about 0.10 to 0.11 per cent can be readily detected by titration of samples of whey taken from the cheese kettle at intervals, with tenth normal alkali and phenolphthalein as in Manns' test. The appearance of lactic acid in the whey can also be detected by the electrometric method, or more simply by adding a suitable indicator to whey samples, taken at fifteen minute intervals. Acid may first appear any time from one to five hours after the milk is in the kettle. Our experiments to be published later show the importance of acid development.

[1] Published with the permission of the Director of the Wisconsin Agricultural Experiment Station.

Electrometric determination on whey from the Swiss cheese kettle, kindly made for us in the laboratory of the University of Wisconsin Soils department by Horace J. Harper, Ph.D., Associate Professor of Soils, Iowa State College, show what may be expected. A sudden change occurs in the direction of the curve of pH values, when lactic acid formation begins. For cheese factory purposes, the use of an indicator should detect the same change, closely enough.

As long as the whey is quite sweet, 1 drop (or 2 drops) of 0.01 per cent solution of brom-cresol-purple indicator added to 1 cc.

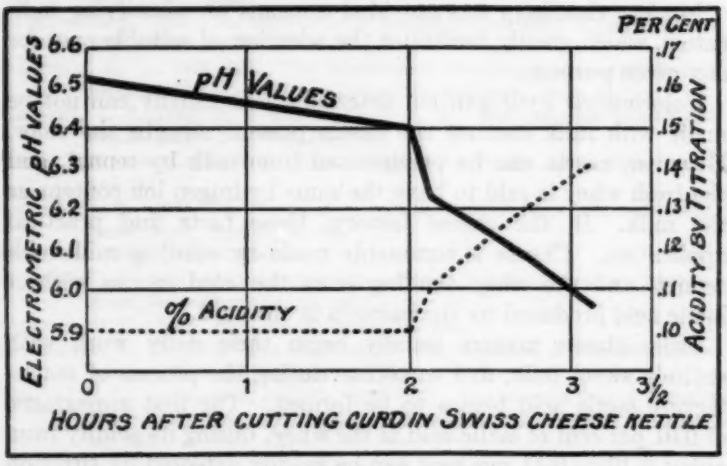

FIG. 1

of the well mixed whey in a test tube gives a distinct purple color, readily seen by comparison with another tube containing whey alone. When acid development begins in the kettle by bacterial action, the test shows gray, and with more acid, a yellow tint. Experience in this laboratory shows that this gray color change may be used as a guide by the cheese maker who has been waiting for acid development to begin in the kettle before he proceeds to the final steps in the Swiss cheese making process. The yellow color appears at about the point of acidity, 0.17 to 0.18 per cent, at which the American cheese maker draws the whey.

In a similar way, various indicators are being tried as means to detect the critical degrees of acidity required at important points in the manufacture of other kinds of cheese.

The test described above has been in use during several months past in cheese making experiments at the University of Wisconsin Dairy Department. The color test requires less time than the acidimeter test, and may become a distinct aid to the busy cheese maker in his daily work, although it can not replace the acidimeter in testing starters and other products of high and variable acidity.

THE INFLUENCE OF CERTAIN FACTORS ON THE HYDROGEN ION CONCENTRATION OF MILK. I

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This paper contains the results of an attempt to determine some of the causes influencing the reaction (acid or alkaline) of freshly drawn cow's milk. Various explanations have been offered to account for the acidity of fresh milk. Bordas (1) claimed the original acidity of cow's milk was due to free casein and not to lactic or citric acid or acid salts. Van Slyke and Bosworth (2) claim that the acidity of fresh milk is due to acid phosphates of the type MH_2PO_4. When titrated with NaOH insoluble $CaHPO_4$ is formed which hydrolyses to $Ca(OH)_2$ and H_3PO_4. The $Ca(OH)_2$ then unites with the di- and monocalcium phosphates to form insoluble tricalcium phosphate $Ca_3(PO_4)_2$ leaving the molecule of H_3PO_4 to react with more alkali.

Several factors are considered as influencing the acidity of milk, among which are the following: chemical composition (3), temperature of milk (4), pasteurization (5), feed (6, 7, 8, 10), age of cow (8), period of lactation (6, 8), and sickness (6).

There are three recognized ways of determining acidity in milk: titration with 0.1 N NaOH and phenolphthalein, Van Slyke's and Bosworth's modification of the above method and the determination of the hydrogen ion concentration.

Van Slyke and Baker (5) showed a definite relationship between the total (titratable) and actual acidity in milk. Further data is presented in this paper to show the relationship between the two ways of determining the acidity of milk.

EXPERIMENTAL

The following factors were studied in this investigation:

1. Effect of feeding acetic, butyric, lactic, and phosphoric acids.

2. Effect of changing from dry feed to pasture.

The cows used in this investigation were cows 43, 229 and 297 of the Purdue Dairy herd and were kindly loaned to the author for this work. Cow 43 was a Holstein, the other 2 were Jerseys. The cows had been giving milk for ten months at the time the experiments began and were receiving the following rations:

Grain mixture
- 4 parts corn meal
- 2 parts wheat bran
- 2 parts ground oats
- 1 part oil meal (linseed)
- 1 part cotton seed meal

Daily ration

COW NUMBER	GRAIN	SILAGE	ALFALFA
	pounds	*pounds*	*pounds*
43	16.5	30	10
229	15.0	24	10
297	12.0	24	10

Cow 229 received 1½ pounds of cottonseed meal per day in addition to the above during the first few weeks of the experiment. The cows all had automatic watering cups attached to their mangers, enabling them to have all the water desired. All cows were milked and fed three times per day until just before going on grass when nos. 229 and 297 were only milked twice per day.

Method of feeding the acids. The acids were fed by being thoroughly mixed with the grain in the evening at 7:00 p.m. just previous to the evening milking. No difficulty was experienced in getting the cows to eat the ration thus prepared until butyric and acetic acids were tried. After the first time, no difficulty was encountered with the butyric, but it was found necessary to dilute the concentrated acetic with an equal volume of water when the larger amounts were fed.

Careful notes were taken at all times on the behavior of the cows, the changes in weather, and the behavior of the apparatus.

Methods of sampling. Immediately after being milked, the milk was thoroughly stirred in the pail by means of a small dipper; the sample put in a small carbon dioxide flask and a few drops of toluol added to prevent bacterial action.

The samples were then cooled under the tap and kept cool until the determinations could be made. About an hour usually elapsed from the time the first sample was taken until the apparatus was set up and the first determination started. The time was recorded in all cases.

During the experiments the samples were taken from the morning milkings, unless otherwise specified, as in a few cases, where noon samples were used. The weight of the milk given per day for each cow is also included in an attempt to study what relation, if any, exists between the amount of milk given per day and the hydrogen ion concentration and the total acidity of the milk.

Control of temperature. The samples were kept cool by tap water until time to make the determinations, when they were warmed to about 21° to 22°C. by rotating in hot water, removing and shaking. It was possible by this method to keep the temperature variations for the titrations within a range of 3°C. The temperature of the samples for hydrogen ion determinations was governed by the temperature of the hydrogen in the tank, which seldom varied more than from 21° to 23°C. The temperature factor was also taken care of in the pH determinations by using the "difference of potential" factors worked out by Sorensen (9).

The apparatus. The apparatus used in this work consisted of a saturated calomel electrode, a modified Hildebrand hydrogen electrode, a storage battery wired to deliver 4 volts, a tank of hydrogen and two wash bottles containing alkaline pyrogallate and one containing water to wash the gas; a Leeds & Northrup Student's potentiometer, a resistance box and a galvanometer, were used to measure the potential.

The hydrogen was washed through the alkaline pyrogallate solution to remove the oxygen. The saturated calomel electrode was chosen because it is less influenced by a change in temperature and there is less contamination by diffusion from saturated KCl used in the bridge during the determinations, and, also less trouble from a difference of potential at the surface of contact of the liquids. The apparatus as used is sensitive to a change of 0.02 to 0.03 of a pH unit.

Method used to determine the hydrogen ion concentration. In making the pH determinations the sample was first brought to the proper temperature, as previously described, thoroughly shaken, about 20 cc. placed in a vessel (made by cutting a 100 cc. graduated cylinder off at the 30 cc. mark), the hydrogen electrode immersed in the milk and hydrogen bubbled through swiftly with occasional shakings for about five minutes, when the speed of bubbling was decreased somewhat. After about ten minutes had elapsed, readings were taken by immersing the tip of the calomel electrode in the milk and making the reading on the potentiometer when adjusted to show no current passing through the galvanometer.

After making the reading the calomel electrode was removed until a second reading was made two to three minutes later. Occasional readings were taken in this way until the sample and the electrodes had reached equilibrium. The final reading was taken with the gas bubbling through the milk at the rate of about 2 bubbles per second. Before making a final reading the resistance boxes were adjusted to be in equilibrium with the standard Weston cell. The following formula was used in making the calculations from the potentiometer readings:

$$\frac{\text{E.M.F. (observed)} - \text{E (calomel electrode)}}{0.0001983\ \text{T}} = \log\frac{1}{\text{H}} = \text{pH}$$

E.M.F. = the potentiometer reading in volts
E = the potential difference, referred to the normal hydrogen electrode of the saturated calomel electrode
T = absolute temperature

A sufficient number of the determinations were run in duplicate to insure the accuracy of the method, and the apparatus. The apparatus was also checked against standard buffer solutions from time to time as occasion seemed to demand.

The method used to determine the total acidity. The titration method previously described was used with the following modifications: only 50 cc. of milk were used for the titration, and the results doubled to represent values for 100 cc.

The effect on the acidity of milk of feeding certain acids to cows. The determinations were run on the milk for three days with the cows on a normal ration before starting to feed the acids. In the case of cow 297 the determinations were made again on normal feed after the lactic acid trials, while cow 43 was changed to a ration containing butyric acid. Cow 229 was used as a check and received no acid. Below are the results of the acid trials.

Discussion of the acid trials. From a study of the data in table 1 no striking changes seem to have been caused in either the H ion concentration or the total acidity by the presence of acids in the rations. Cow 297 received 85 per cent lactic acid as follows for a period of fourteen days; first four days 20 cc. per day; second four days 40 cc. per day; last six days 80 cc. per day; then followed a period of nine days when no acid was fed, then for a period of six days 50 cc. of 85 per cent phosphoric acid was added per day. No greater variation was noticed than is shown for cow 43 in table 1. Cow 229 was used as a check and received no acids in her feed. Her milk showed the same amount of variation as shown by the milk of the other cows. The small daily variations likely result from minor physiological disturbances.

Where the range is wide, a relation is shown to exist between a change in total acidity and a change in pH value; where the changes are small, no such relation holds true.

No apparent relation exists between amount of milk given per day and either the pH value or the total acidity.

From the foregoing data it would seem improbable that the reaction of cow's milk is influenced by the acidity of the ration.

TABLE 1

Reaction of milk when the acids were added to the ration: cow 43

DATE	POUNDS OF MILK PER DAY	H^+ ION CONCENTRATION AS pH	TEMPERATURE OF MILK FOR pH DETERMINATION	TOTAL ACIDITY cc. N/10 NaOH	TEMPERATURE OF MILK FOR TOTAL ACIDITY	AMOUNT AND KIND OF ACID FED PER DAY
1919			°C.		°C.	
April 11	36.2	6.52	20.0	23.00	20.0	None
April 12	37.7	No sample taken				None
April 13	38.4	6.58	21.0	25.40	23.0	None
April 14	39.3	6.53	22.0	24.90	24.0	20 cc. 85 per cent lactic
April 15	39.8	6.50	25.0	25.50	24.0	20 cc. 85 per cent lactic
April 16	39.7	6.55	22.0	25.05	23.0	20 cc. 85 per cent lactic
April 17	39.6	6.55	22.5	25.60	23.0	20 cc. 85 per cent lactic
April 18	37.9	6.54	20.0	25.70	22.0	40 cc. 85 per cent lactic
April 19	39.1	6.53	22.0	26.10	24.0	40 cc. 85 per cent lactic
April 20	40.0	6.53	21.5	25.09	22.0	None
April 21	38.4	6.53	21.0	25.75	23.0	None
April 22	40.4	6.50	24.0	26.15	24.0	None
April 23	39.5	6.54	20.0	26.95	21.0	40 cc. 60 per cent butyric
April 24	39.5	6.44	21.0	26.30	22.5	40 cc. 60 per cent butyric
April 25	39.9	6.43	22.0			40 cc. 60 per cent butyric
April 26	39.9	6.42	23.0	25.10	23.5	80 cc. 60 per cent butyric
April 27	41.9	6.51	21.0	25.20	23.0	100 cc. 60 per cent butyric
April 28	42.2	6.54	21.0	25.00	23.0	100 cc. 60 per cent butyric
April 29	38.9	6.61	20.5	23.80	23.0	None
April 30	40.5	6.49	21.0	24.80	22.5	None
May 1	41.6	6.50	21.5	24.30	23.0	None
May 2	41.6	6.56	22.5	23.90	23.5	None
May 3	40.8	6.48	24.0	24.00	25.0	None
May 4	42.6	6.46	23.0	24.10	25.0	None
May 5	42.9	6.56	21.5	24.00	23.0	None
May 6	40.9	6.56	21.5	23.40	22.3	None
May 7	No samples taken					50 cc. glacial acetic
May 8	41.6	6.50	20.0	23.30	21.0	50 cc. glacial acetic
May 9	43.2	6.45	22.0	23.70	23.0	50 cc. glacial acetic
May 10	41.4	6.48	22.5	23.00	24.0	50 cc. glacial acetic
May 11	39.8	6.56	22.0	23.70	23.5	None
May 12	37.5	6.50	23.5	21.60	24.0	None
May 13	33.6	6.44	22.0	24.52	23.0	None

Effect of changing from winter ration to summer ration. In table 2 data are presented to show the effect of changing from a winter ration including no pasture, but including silage, to a summer ration containing pasture instead of silage.

From the averages in the pH value little change can be detected. A small increase in acidity, as pH, is noted with cow 43, a similar decrease with cow 229; a larger decrease in acidity as pH, is however shown with cow 297. These changes, partly contradictory, are probably, but not necessarily, due to other causes than the change of ration.

Quite uniform decreases in total acidity are shown when the averages representing the winter ration are considered. This decrease holds in all cases. Further work is desirable here, in order to determine what change, if any, is shown by the solid constituents of milk when a grass ration is substituted for a winter ration. The above results also corroborate the statement made previously that a close relationship does not necessarily exist between the pH and the total acidity.

TABLE 2

Effect of dry feed compared to pasture on acidty of milk

COW NUMBER	DATE		POUNDS OF MILK PER DAY	H^+ ION CONCENTRATION AS pH	TOTAL ACIDITY, CC. N/10 NaOH	KIND OF RATION
	From	To				
	1922	1922				
43	April 28	May 2	42.0	6.54	24.83	Dry
43	May 23	May 27	34.9	6.51	22.31	Pasture
297	April 28	May 2	22.0	6.53	24.32	Dry
297	April 23	May 26	18.4	6.61	19.54	Pasture
229	April 11	April 15	26.75	6.63	24.99	Dry
229	May 23	May 27	17.1	6.65	21.55	Pasture

From the foregoing, it seems possible to influence the total acidity of milk by a change from a winter to a pasture ration, but not the pH value. More work is desirable along these lines.

CONCLUSION

Studies were made to determine the effect of feeding lactic, butyric, acetic and phosphoric acids in the H^+ ion concentration and total acidity of milk; to determine the changes, if any, produced when the cows were changed from a dry ration to a pasture ration. Little, if any, effect on the reaction of milk was noticed from feeding the above mentioned acids, either on the H^+ ion

concentration or total acidity. A marked decrease in total acidity was noted when the cows were changed from the winter ration to the summer ration, with practically no change in the pH value.

The author takes this occasion to thank Dr. Ernest Anderson, of the University of Nebraska, for very kindly suggesting the problem and preliminary methods, the Purdue Dairy Department for loaning the cows, Dr. P. N. Evans of the Chemistry Department of Purdue, for furnishing supplies, and Dr. Hoffer and Mr. John Trost for the use of their laboratory and apparatus.

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STUDIES IN THE GROWTH AND NUTRITION OF DAIRY CALVES

IX. THE ADDITION OF TOMATOES TO A MILK RATION

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In an effort to determine some of the fundamental principles underlying nutrition in general, and calf feeding in particular, a number of investigations have been under way for five years. In papers V and VI of this series, attention was given to the bulk supplied to young calves, though subsidiary problems also occurred. This paper simply includes further work on the influence of bulk on the value of the ration for a young growing calf, though at times other branches of the work have to be brought in.

RÉSUMÉ OF PREVIOUS WORK

All of the work dealing directly with the provision of bulk in the ration of the calf has been reviewed in the two previous reports, but attention may be drawn here to recent work which is applicable to some extent to this problem.

In papers V and VI of this series it was found that milk alone was not a good ration for calves but a ration of milk and grain was even poorer as the grains added so much more magnesium to the ration that the calcium used in the removal of the magnesium had actually to be withdrawn from the body stores. The introduction of alfalfa hay to the ration caused rapid improvement in the lime-magnesia ratio and so lead to a positive calcium balance. The bulk of the alfalfa hay was also of great value in bringing the digestion of the calves to normal as bulky feeds are necessary for the distension of the rumen and other parts of the digestive tract.

Since the compilation of the work by Eddy (64) on the distribution of the vitamines, it is easier to determine what influence the vitamines may have had in the work reported in papers V and VI.

From this it is apparent that the milk was supplying as much fat-soluble A and water-soluble B and considerably more water-soluble C than any of the grains used or than the alfalfa. Consequently the recovery of the calves when fed alfalfa hay can not be looked on as due to any additional amounts of water-soluble C provided. This means that only the calcium content of the alfalfa hay or its bulky nature could have been of value in improving the ration of the calves.

TABLE 65

Distribution of vitamines, from Eddy (64)

SOURCE	FAT-SOLUBLE A	WATER-SOLUBLE B	WATER-SOLUBLE C
Milk	xxx	xxx	xx
Alfalfa	xxx	xxx	?
Corn, yellow	x	xxx	?
Corn, white	0	xxx	?
Oats	x	xxx	0
Bran	0	x	0
Oil meal	xx	xxx	
Tomatoes, canned			xx

xxx indicates abundance, xx relatively large amounts, x present in small amounts, 0 absent.

On feeding grain and oat straw to goats for three months, Steenbock and Hart (67) found that the calcium balance remained negative. Then there were indications of approaching collapse on the part of the animals, such as lack of appetite and loss of interest in their surroundings. Fresh grass was then fed to the animals and they recovered.

Later Hart, Steenbock and Hoppert (65) continued this wo using dry and milking goats. When fresh green oats were fed the cacium balance was positive but on feeding oat straw, the calcium balance was negative. When the fresh green oats were dried in a well lighted and well ventilated attic but out of direct sunlight, they still retained some of the properties which aided in

calcium assimilation. It was also found that alfalfa hay kept up the calcium balance. Orange juice and cabbage had not this power so it can not be the antiscorbutic vitamine that aided calcium assimilation, but rather an antirichitic vitamine also found in cod-liver oil.

EXPERIMENTAL WORK

In the trial reported here 2 calves were used and although they were born some time apart, the records have been kept for each by thirty-day periods. Information concerning these animals is given in table 66. Calf 544 was twinned with a bull and was therefore presumed to be a free-martin, but a discussion of its sexual make-up will be taken up later. Calf 539 died at 180 days of age, being on a ration of milk alone, while calf 544 was killed

TABLE 66

Animal used

	CALF 539	CALF 544
Breed	Grade Jersey	Holstein
Sex	Male	Free-martin
Date of birth	November 3, 1920	December 26, 1920
Birth weight, *pounds*	55	65

after the completion of the fifteenth period. During the trial it had been fed milk, milk and canned tomatoes, and milk and alfalfa hay.

The feed consumption for each calf is presented by thirty-day periods. Calf 539 was fed milk alone and died at 180 days of age. Calf 544 was fed milk alone until the end of period VII when his appetite had decreased. An allowance of 1 pound, 3 ounces of canned tomatoes was then given for five periods but as this did not produce the desired improvement, alfalfa hay was fed at free-will until the trial was closed.

The live weights of the experimental calves were obtained at birth and at the end of each thirty-day period, by weighing on three consecutive days. The body measurements, height at withers, depth of chest, and width at hooks were obtained at the end of each period.

TABLE 67

Feed consumption by thirty-day periods

PERIOD NUMBER	CALF 544			COW 539
	Whole milk	Canned tomatoes	Alfalfa hay	Whole milk
	pounds	*pounds*	*pounds*	*pounds*
I	360			221
II	420			323
III	467			409
IV	624			495
V	765			645
VI	1181			675
VII	1125			
VIII	1125	36		
IX	1125	36		
X	1305	36		
XI	1310	36		
XII	1350	36		
XIII	1500		280	
XIV	1500		206	
XV	1500		285	

TABLE 68

Live weight and body measurements

AGE	AVERAGE FOR 40 HEIFERS				CALF 544				CALF 539			
	Weight	Height	Depth	Width	Weight	Height	Depth	Width	Weight	Height	Depth	Width
days	*lbs.*	*in.*	*in.*	*in.*	*lbs.*	*in.*	*in.*	*in.*	*lbs.*	*in.*	*in.*	*in.*
Birth	67				65				55			
30	90	28.7	11.4	6.7	99	32.7	14.8	7.8	72	31.6	13.7	8.0
60	120	30.7	12.8	7.5	150	33.3	15.1	8.6	91	32.6	14.1	8.0
90	163	32.9	14.2	8.5	183	33.9	15.6	9.2	123	33.3	14.2	8.0
120	211	34.8	15.4	9.4	251	34.5	16.0	9.4	165	35.1	15.3	8.9
150	262	36.4	16.7	10.2	301	36.9	17.2	10.3	237	36.2	16.1	9.5
180	314	38.4	17.9	11.2	390	39.0	18.2	11.5	250	37.0	16.5	9.7
210	366	39.4	18.7	11.8	437	40.3	19.1	12.3				
240	413	41.0	19.5	12.6	479	41.5	20.3	12.9				
270	452	42.0	20.3	13.2	481	43.0	21.3	13.3				
300	486	42.7	20.9	13.6	537	46.9	21.5	13.9				
330	521	43.5	21.5	14.2	554	47.6	21.7	14.0				
360	557	44.3	21.9	14.6	630	48.2	22.1	14.8				
390	592	44.9	22.4	15.1	721	49.4	22.7	15.4				
420	628	45.5	22.8	15.4	750	50.0	24.3	16.0				
450	659	45.9	23.2	15.7	795	50.8	25.7	16.0				

RESULTS SECURED

If the increase in live weight and body measurement be taken each third month and expressed as percentages of the first measurements taken, they can be compared with the averages for a group of 40 heifers raised normally and reported in paper III of this series. In making this comparison in table 69 it will be found that calf 539 shows a tendency throughout to be below normal in both live weight and body measurements. On the other hand, calf 544 always shows a higher rate of increase in live weight than is found in the normal group. However, this calf shows slow development in the body measurements until the alfalfa period is reached.

TABLE 69

Percentage increase in live weight and body measurements

AGE	AVERAGE FOR 40 HEIFERS				CALF 544				CALF 539			
	Weight	Height	Depth	Width	Weight	Height	Depth	Width	Weight	Height	Depth	Width
months	lbs.	in.	in.	in.	lbs.	in.	in.	in.	lbs.	in.	in.	in.
3	143	15	25	27	181*	4	4	18	124	5	4	0
6	369	34	57	67	500	19	12	47	354	14	21	21
9	575	46	78	97	640	31	44	71				
12	731	54	92	118	869	47	50	90				
15	884	60	104	134	1123	55	74	105				

It is well to study the requirements of the calves and the supply of nutrients supplied to them as this gives an idea of how far their rations meet their needs for nutrients, and other factors concerning the rations can be considered later. The nutrients required by and supplied to the calves have been calculated from the work of Henry and Morrison (66). To simplify matters however, the excess or deficit of nutrients supplied during each thirty-day period has been calculated for each calf.

The calf 539 always had an oversupply of nutrients until the end of the fourth period. Then the supply of total dry matter dropped below normal and the supplies of digestible nutrients came down to near the actual requirements. In the next period

the deficit of dry matter was even greater and the supply of digestible crude protein and digestible carbohydrate equivalent was below that required by the calf. The animal was given all the milk it could handle and yet could not obtain sufficient nutrients from it and the calf died at 180 days of age.

In the case of the larger calf 544, there was a deficit in the dry matter supply from the first period. This deficit varied irregularly but at the end of period VII, it was greater than at the

TABLE 70

Percentage of nutrients in addition to requirements provided

PERIOD	CALF 544			CALF 539		
	Total dry matter	Digestible nutrients		Total dry matter	Digestible nutrients	
		Crude protein	Total		Crude protein	Total
	per cent	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*
I	−56	60	64	11	20	25
II	−62	36	44	26	38	7
III	−68	13	17	23	31	38
IV	−68	10	16	10	17	24
V	−69	4	11	−39	4	10
VI	−78	40	38	−48	−10	−5
VII	−68	36	10			
VIII	−85	32	2			
IX	−85	28	−2			
X	−84	47	3			
XI	−85	36	−2			
XII	−86	29	−4			
XIII	−22	130	54			
XIV	−42	90	33			
XV	−25	108	40			

beginning of the trial. At the start of the trial the calf consumed enough milk to provide a large excess of nutrients, but this excess decreased irregularly and reached a low point for total nutrients during period VII.

At the beginning of period VIII canned tomatoes were introduced into the ration and were fed with the milk for five periods, but during this time the deficit in dry matter consumed became greater. The amount of digestible protein consumed also de-

creased and where there had previously been an excess of total digestible nutrients a deficit became apparent.

At the beginning of period XIII the feeding of canned tomatoes was stopped and alfalfa hay was introduced into the ration. The deficit in dry matter was immediately largely reduced though it had not entirely disappeared when the calf was slaughtered after 90 days on this ration. The supply of total digestible nutrients was also immediately converted from a deficit into a surplus and the supply of protein was also greatly augmented.

BEHAVIOR OF THE CALVES

The calf 544 did not show any peculiarities in action until the fifth period when it started to chew the wooden walls of the pen and in period VI it showed signs of irritability or nervousness. These peculiarities continued to some extent until alfalfa was introduced into the ration. In period VII, just before the feeding of tomato juice was started, the calf was stiff in the joints and had a stilted gait. About this time the lack of middle in the calf also became apparent. The eyes also did not appear normal; they were watery and dull. When the tomato juice was introduced the calf picked up, walked better and its eyes appeared to be well, but within two months it was back in the old condition and the leg joints became puffy. This lasted until the introduction of alfalfa hay to the ration when the calf started to regain a normal appearance and looked in good shape when the trial ended.

In the case of calf 539 somewhat similar conditions prevailed. It started chewing wood in the second period and by the third period was extremely nervous even when touched. It continued in this condition until its death at the end of period VI.

POST-MORTEM EXAMINATION OF CALF 544

The calf 544 was killed at the end of the fifteenth period and an autopsy was conducted by Dr. E. A. Benbrook of the Department of Veterinary Pathology and Bacteriology, while Dr. H. S. Murphy of the Department of Veterinary Anatomy examined the sexual organs of the calf.

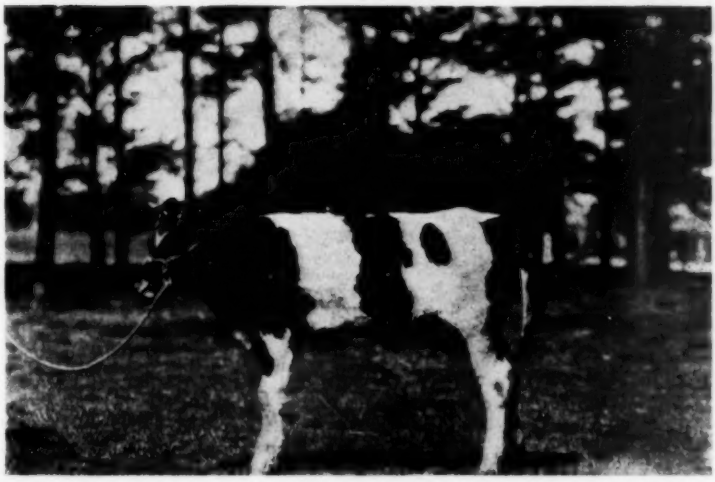

FIG. 1. CALF 544 JUST BEFORE CANNED TOMATOES WERE ADDED TO THE RATION

Note gaunt appearance. Age, 7 months

FIG. 2. CALF 544 AT TIME OF REMOVAL OF CANNED TOMATOES FROM AND ADDITION OF ALFALFA HAY TO RATION

Note poorer appearance and sunken eye. Age, 12 months

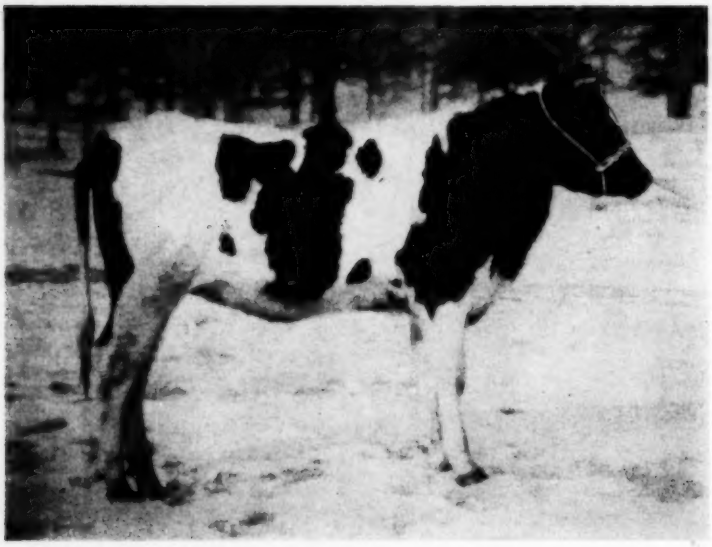

FIG. 3. CALF 544 AFTER A RATION OF MILK AND ALFALFA HAY FOR 3 MONTHS
Note bright appearance and development of middle. Age, 15 months

FIG. 4. CALF 539 ON A RATION OF MILK ALONE
Age, 4 months

The animal was in fair condition and the abdomen was fairly well rounded yet flaccid. The condition of the skin was fair, though that in the region of the cheeks and jaws was dry, harsh, scaly and partly denuded of hair.

The stomach

The rumen, reticulum and omasum appeared to be normal in size, whereas, the abomasum was voluminous for an animal of this size. The contents of the stomach compartments were about normal, but in the rumen there were two hair balls, one about 4 inches in diameter with a brown smooth coat and the other about 1½ inches in diameter and uncoated. The reticulum contained no foreign bodies except a small amount of sand and cinders. The mucosa of the abomasum was slightly catarrhal.

The intestine

In both the large and small intestine the mucosa was somewhat catarrhal.

The glands

The liver was enlarged by about one-third, was pale yellowish-red in color, mottled and friable. The gall bladder contained a number of concretions and the mucosa was slightly catarrhal. The pancreas was slightly enlarged. The spleen was slightly enlarged. The mesenteric chain of lymph nodes were all somewhat enlarged and the cortex in most cases was slightly reddened. In some petechial hemorrhages were noted. The remainder of the lymphatic system was apparently normal so far as could be noted in the examination. The kidneys were slightly enlarged and pale. One kidney contained a retention cyst the size of a pea.

The thyroid glands were flattened and irregularly lobulated. The gland tissue was pale red in color and apparently interspersed with strands of connective tissue. The cut surface was shiny and rather sticky. The parathyroids were flattened and about the size of a pea. The thymus gland was large in its

extra-thoracic position, extending up to the larynx, and most of the gland lobules showed petechial hemorrhages. The intra-thoracic portion of the gland was small.

The skeletal tissues

The skeleton showed no noticeable changes. Cross sections of the ribs above and near the sternum and of the left tibia appeared to be normal.

The genital organs

This animal as mentioned earlier was twinned with a bull, but from anatomical and histological examination, Dr. H. S. Murphy of the Department of Veterinary Anatomy was of the belief that the animal was potentially a bull though sexual development had been arrested.

POST-MORTEM EXAMINATION OF CALF 539

This animal was examined shortly after death by Dr. E. A. Benbrook of the Department of Veterinary Pathology and Bacteriology.

The stomach

The rumen was about the size of the other three compartments of the stomach and it contained a grey-brown opaque liquid. An oval uncoated hair ball about 2 inches long and 1 inch in diameter was found in the rumen. The abomasal mucosa showed hemorrhages.

The intestine

The intestine showed no changes of importance.

The glands

The liver showed a cloudy swelling and a few subcapsular hemorrhages, while the gall bladder contained a small amount of yellow cloudy bile. All of the lymph nodes were enlarged and congested and those of the viscera showed hemorrhages. The kidneys showed cloudy swellings and were congested. The thymus gland was large and showed hemorrhages throughout.

The skeletal tissues

The femur and humerus showed a peripherally red marrow but the osseous tissue was apparently normal. The joints of the legs were enlarged.

Cause of death

The ultimate cause of death was hemorrhagic septicemia which had a good opportunity for development owing to the lowered condition of the calf.

DISCUSSION OF RESULTS

From the work presented in this and the two earlier papers in this series which deal with the problem of restricted rations for calves, it is apparent that milk is not suitable as the sole feed for calves when fed for any considerable time. From the amount of milk consumed by the calves on a ration of milk alone, it is apparent that they were being supplied with sufficient digestible nutrients for a time, but later on in the trials they could not consume enough milk to provide all the digestible nutrients they required.

At a much earlier stage in the trials the dry matter provided by the milk rations fell below the requirements of the calves and so it would appear that the calves were not being supplied with enough dry matter, especially in the form of bulky constituents.

It has been sometimes believed that milk was at times deficient in the vitamine water-soluble C, but from the bibliography presented and the results of the trial reported here on the addition of tomato juice to a milk ration, it becomes apparent that the vitamine fat soluble A, water-soluble B and water-soluble C, were present in sufficient amounts and did not cause the inefficiency of milk when used as the sole ration.

The one point of importance brought out by the results reported here is that the addition of a roughage such as alfalfa hay to a milk ration will bring the calves through in good shape even though they have gone off badly on a ration of milk alone. There may be three factors which render such a roughage valuable in the ration.

It is to begin with bulky and thus renders possible the proper distention and development of the rumen and other portions of the alimentary tract even at an early age. It has already been shown in a previous paper in this series that the addition to a milk ration of grains relatively rich in magnesium and poor in calcium will prevent the proper deposition of calcium in the skeletal tissues. Alfalfa hay is rich in calcium and so aids in maintaining the proper calcium balance.

As has been shown in the résumé of previous work certain green plants, such as oats, contain an antirachitic vitamine which aids calcium assimilation. By careful curing part of this vitamine is retained. The alfalfa hay used in this trial was of the second cutting and was put up rapidly without much exposure to direct sunlight, so there is a possibility that it contained some of this vitamine and was thus of greater value to the calf.

SUMMARY

From the work reported here it would appear that:

1. Milk can not be used as the sole ration for calves indefinitely.
2. A lack of the vitamines fat-soluble A, water-soluble B and water-soluble C, is not a cause of the inefficiency of milk.
3. A bulky roughage appears to be necessary for the calf.
4. A roughage such as good pea-green alfalfa may also provide some of the antirachitic vitamine and add to the lime supply of the calf.

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ANNUAL MEETING OF THE AMERICAN DAIRY SCIENCE ASSOCIATION

The eighteenth annual meeting of the American Dairy Science Association was held in the Court House at Syracuse, New York, October 8 and 9, 1923. The meeting was called to order by President Borland. After a few remarks he called for the report to the secretary-treasurer. The secretary-treasurer also read a financial statement and accountant's report of the condition of the books.

The Executive Committee submitted a budget of $550 to cover expenses of various offices and sections for the coming year. The budget was adopted.

J. A. Gamble reported for the Southern Division.

R. C. Fisher reported for the Eastern Division.

A report of the meeting to federate all dairy organizations was given by O. E. Reed.

J. A. Gamble reported as representative of the Association to the National Research Council. In connection with the National Research Council, H. P. Davis moved that the President in consultation with the Executive Committee and the American Society of Animal Production make such recommendations as they think will be in order. Seconded by Ragsdale. Passed.

C. H. Eckles reported as a member of a committee on relation with the National Research Council. He suggested that the previous motion be amended so that a representative from the Dairy Science Association to the Research Council be elected with the other officers for a period of three years.

Professor Hooper of Kentucky report on Southern Dairy Cattle Judging contest at Memphis.

C. W. Larson reported as a representative to a meeting of the American Biological Society. As a result of this report it was moved and passed that a committee be appointed to study the

matter of affiliation with the American Biological Society and report back to the Society in the future.

The following men reported briefly as officers of the different sections: Section I, O. E. Reed; Section II, H. A. Ruehe; Section III, E. M. Harmon; Section IV, George C. White.

Dr. Rogers briefly reported progress of the committee on Bacteriological Standards.

J. H. Frandsen, editor of the JOURNAL OF DAIRY SCIENCE, and Mr. E. H. Williams, representing Williams & Wilkins who publish the JOURNAL, spoke briefly regarding future plans for the JOURNAL.

A. J. Glover presented a resolution to be sent to the President of the United States requesting that the Dairy Division of the Department of Agriculture be changed to the Bureau of Dairying. This resolution was adopted.

The President appointed C. H. Eckles, C. W. Larson and R. S. Breed to recommend action of the American Dairy Science Association as to membership in the Union of American Biological Societies.

The President also appointed R. R. Graves, C. H. Eckles, C. W. Larson, J. A. Gamble and R. S. Breed to meet with the American Society of Animal Production and Society of Genetics and agree on matters to present to the National Research Council.

Brief reports were then given covering the work taken up in this year's sectional meetings.

Professor J. A. Gamble Secretary of the Production Section gave the following report:

The Production Section of the American Dairy Science Association was called to order by Chairman O. E. Reed at 9:30 p.m. October 9, 1923.

There were forty men present representing over twenty different "Dairy Husbandry Departments."

In the absence of the permanent Secretary, J. A. Gamble was asked to act in that capacity. Because of the absence of the President, O. E. Reed, in Europe during the past summer and the fact that the program was generally merged with the World's Dairy Congress, no official program of papers had been prepared.

A discussion relative to the standardization of research technique was lead by C. H. Eckles which brought out may interesting points. As a result of the discussion, the following committee was appointed to study the research report soon to be made available by the National Research Council and to bring in a report regarding the outline for research technique. The committee consisted of C. H. Eckles, H. P. Davis and E. P. Meigs.

W. W. Swett rendered a very able report for the Dairy Cattle Judging contest and also raised the point that the breeder of Brown Swiss wished to have their breed included in the judging contest. This matter was discussed at length by many of those present and it was finally voted to refer it to the departments eligible to send teams for further action at the meeting next year.

The matter of absences of judging teams from College was discussed at length and the matter finally laid on the table. H. P. Davis of Nebraska offered a resolution thanking the United States Department of Agriculture and through it, the United States Dairy Division, for the very great help and assistance rendered the American Dairy Science Association in the contest and other work.

Election of officers for Section I, as follows: J. J. Hooper of Kentucky, Chairman, J. A. Gamble of Maryland, Secretary.

Professor A. E. Dahlberg reported as follows from the Dairy Manufacturers' Section:

Dairy Manufacturers' Section of the American Dairy Science Association was called to order by Chairman Ruehe, Illinois October 8, 1923, in the Court House at Syracuse, New York. In the absence of Secretary Kiethley, P. S. Lucas was elected acting secretary.

Reporting the work of the Committee on Standards for Creamery Glassware, Professor Hunziker stated that there had existed an impression that standards held by the United States Bureau of Standards and those advocated by the American Dairy Science Association were at variance. That this impression is erroneous

was pointed out by the Committee at the last meeting at St. Paul. This impression gained credence because the standards adopted by the Bureau had not been given publicity. At the instance of the Committee these standards have been printed in practically the entire dairy press and copies may be obtained from the Committee Chairman, Professor Hunziker. The standards of the Bureau and Association are identical in every detail.

Reporting further, Professor Hunziker stated that a conference had been called of members of the Dairy Science Association and the United States Bureau of Chemists by Dr. Hortvet, for the purpose of formulating specifications for Standard Babcock Glassware for recommendation to the American Association Official Agricultural Chemists. Professors Hunziker, Bouska, and Dahlberg represented the Dairy Science Association. The specifications of the United States Bureau of Standards and the Dairy Science Association were adopted in full by Dr. Hortvet's committee. There is every reason to believe that these standards will be adopted by Dr. Hortvet's association. It is the wish of Professor Hunziker's committee that each state dairy department will familiarize itself with these specifications and exert its influence, when occasion arises to work toward their adoption in the respective states. The committee's report was adopted.

Commenting on the work of the Committee on Students Dairy Products Judging Contests, Professor Judkins, Massachusetts, was asked to give a report on such contests, especially as held at the Eastern States Exposition, said report to be made at the call meeting at 7.30 p.m., October 9. Chairman Ruehe urged adoption of a uniform set of rules and score cards by all colleges. The questioned Rule 14 was discussed but no action taken. Mr. S. C. Thompson stated that purchase of outside samples for scoring would obviate Rule 14 but that the expense entailed serious consideration. He urged the appointment of a committee to meet with the Dairy Show management to consider the revision of the contest rules.

It was moved by Professor Fisher, Connecticut, seconded and approved, that the old members present of the Committee on

Students' Products Judging Contest confer on rules with Professor Judkins and Secretary Skinner and report results at the call meeting October 9.

Dr. Roadhouse, California, spoke generally of the judging contest and suggested that trophies be awarded only at the banquet, that this sugestion be incorporated in the rules. Mr. S. C. Thompson reiterated this suggestion, and urged further that enthusiasm and interest be encouraged by so systemizing compilation of results that announcement of awards may be made earlier than heretofore.

To encourage training of judges of dairy products and general interest in the quality of dairy products, Dr. Roadhouse urged consideration of association members in the instruction of high school teachers for the training of their students in determining quality of these products.

The second meeting of the Dairy Manufacturers' Section of the American Dairy Science Association was called to order by Chairman Ruehe of Illinois. In the absence of Acting Secretary P. S. Lucas of Michigan, the Chairman appointed A. C. Dahlberg, New York, as acting secretary.

The Chairman then called for the report of the temporary committee on Dairy Products Judging Contests, of which Professor Judkins of Massachusetts was Chairman. Professor Judkins explained that he was Chairman of the Committee on Dairy Products Judging Contests for the Eastern Section of the American Dairy Science Association, and due to the fact that he had a report for this Committee, the Chairman had appointed him, together with other individuals to consider the revision of the Dairy Products Judging Congests for the American Dairy Science Association. The detailed report of the two committees, of which Professor Judkins was Chairman, was then read by him. A copy of this report is attached to the minutes of the meeting. After reading the entire report each point was then read and discussed.

Professor Sommers of Wisconsin suggested that the score card for milk should be revised by omitting the points now allotted to acidity and adding them to flavor. After a brief discussion of

this matter it was referred by Chairman Ruehe to the Permanent Committee on Dairy Products Scoring Contests.

1. The Committee recommended that the score cards for dairy products as formulated by the United States Department of Agriculture should be used in the next scoring contest, and if satisfactory used permanently hereafter.

2. The Committee recommended that in order to simplify the handling of the Students' Dairy Products Judging Contest, that the duties of the Committee on Students' Dairy Products Judging Contest include the question of score cards, grades and standards. Professor Sommers of Wisconsin commented that this was advisable due to the fact that the Permanent Committee on Score Cards should not be burdened with special score cards for students' judging contests. Professor Fisher deplored the present discrepancy between the Government and the American Dairy Science Association score cards on cheese and milk. He pointed out that the United States Department of Agriculture had developed a system of grades and standards which had been published in Service and Regulatory Announcement, United States Department of Agriculture 51 and Handbook for Use in Inspection of Whole Milk, American Cheese, Circular 157. The publication of these grades and standards based on government score cards gives the coaches a definite basis on which to train their students. He considered it therefore very desirable to try the government score cards for one year. Professor Fisher further urged the establishment of one standard score card for each of the Dairy Products and the need of coöperation towards this end with the United States Department of Agriculture.

3. The committee recommended that in view of the present unsettled condition with regard to the score card and grades and standards on ice cream that it should not be included in the regular contest next year; but that a separate judging be conducted by the teams at which the coaches and representative of the United States Department of Agriculture act of judges for the purpose of developing a satisfactory score card and commercial grades and standards.

Professor Olsen of Kansas stated that last year the American Dairy Science Association had changed the score card for milk so that the five points allotted to acidity were given to flavor. The Chairman was asked whether this had been adopted by the United States Department of Agriculture in their score cards. Professor Sommers of Wisconsin responded that he had corresponded with Professor Hammer of Iowa who recommended that the change be made, and that Professor Hammer stated that it had been referred to the committee on score cards, but had not been adopted. Professor Ruehe agreed that this was the understanding.

The Committee recommended that criticisms be given in judging only when a cut in score was made. The maximum cut for any wrong criticism should not exceed one point. Professor Guthrie of Cornell stated that when butter was slightly wavy in color, no cut in score should be made. A student should, however make a note in his criticisms that he observed this condition. Consequently this recommendation of the Committee was illogical. Professor Fisher of Connecticut responded that the judges at Springfield had considered this fact and had allowed for this discrepancy.

Chairman Ruehe then called upon C. E. Lee of Gridley Dairy Company, Milwaukee, for remarks upon this subject. Mr. Lee stated that he had lost considerable faith in the commercial scoring of butter due to the fact that the score was raised or lowered according to market conditions and market demands. He illustrated this by stating that a car of butter made from sweet cream was scored 89 on a falling market in Chicago, and that this same car of butter was later received in New York on a rising market and scored higher than extras. R. C. Potts of the United States Department of Agriculture responded with the statement that this idea of changeable scores was entirely wrong. He stated that it was to the advantage of the dealer in business to argue grades so far as possible to fit market conditions, but that it was entirely possible to score butter very consistently day after day. He suggested that two of the butter judges of the United States Department of Agriculture be placed upon test to deter-

mine how accurate they could judge. After further discussion upon this subject Chairman Ruehe suggested that it would be concluded in order that the subject matter at hand might be covered during the evening.

5. The Committee recommended that ten samples of each product to be judged be used in the scoring contest. The size of the tubs of butter to be used was briefly discussed and the matter was left to the discretion of the Superintendent of the Contest.

6. It was recommended that three samples of each of the products to be judged should be used as a standard and be available for inspection by students with the scores and criticisms as given by the judges. Considerable discussion followed concerning the order in which dairy products should be judged, and how soon after testing the standard scored products a student should be required to judge the particular products reported in the standard. The discussion also brought out the necessity of having nearly all grades of the product reported in each contest.

7. The Committee also recommended that the rules be published one year in advance of the contest.

8. It was also recommended that the coaches be invited to observe the grading of criticisms by the judges.

9. Rule 14 which has been under much discussion was changed so that no coach or any person aiding in training a team may act as an official or be in any way connected with the Dairy Products Exhibit of the National Dairy Exposition.

10. It was recommended that more interest in the contest be promoted by announcing the scores and trophies at a banquet.

The question was raised concerning the desirability of judging milk powders. Chairman Ruehe stated that it had been talked of but never adopted. The report of the committee was then adopted in full.

The committee on the appointment of officers for the ensuing year, of which Professor Roadhouse of California was Chairman, reported as follows: H. W. Gregory, Indiana, Chairman; R. C. Fisher, of Connecticut, Secretary. The Chairman was then instructed to cast a unanimous ballot for them.

Chairman Ruehe then suggested that the new Permanent Committee on Dairy Products Judging Contest and Score Cards for these contests should be appointed by the newly elected officers. Professor Fisher then recommended that due to the absence of the newly elected chairman, that the present chairman should appoint the committee. It was made in the form of a motion and carried. Chairman Ruehe raised the question of the number of members of the committee and their distribution. After considerable discussion the following committee was appointed: Professor H. A. Judkins, Massachusetts, Chairman; Mr. S. C. Thompson, United States Department of Agriculture; Professor M. Mortensen, Iowa; Professor T. D. Turnbow, California; and Professor H. W. Gregory, Indiana.

Mr. R. C. Potts of the United States Department of Agriculture stated that the judging of cream for butter making should be included in the contest due to the fact that the quality of the butter was so dependent upon that of the cream from which it was made. He further stated that the economic phases of dairy manufacturing were not getting due consideration, and recommended a special section for these problems. Professor Roadhouse of California stated that this work should be included in the present Dairy Manufacturers' Section. This belief was also shared by Chairman Ruehe. Mr. Potts made a motion that the Chairman appoint a committee on the economic phases of the dairy manufacturing to care for the needs of that particular angle of the dairy business. The motion was unanimously carried.

Report of Extension Section was given by Professor C. A. Hutton:

The meeting of the Extension Section, American Dairy Scienec Association was held in the Court House, Syracuse, New York, Monday evening, October 8, immediately following a meeting of the American Dairy Science Association. The meeting was called to order by the Chairman, Mr. E. M. Harmon of Missouri. In the absence of the Secretary, Mr. F. A. Buchanan of Virginia, was elected as temporary secretary.

Report of Bull Association Committee. Mr. J. G. Winkjer, Dairy Division, chairman of the committee, was absent and Mr.

L. A. Higgins of Mississippi, one of the other members of the committee, made a brief report stating that the committee has been working on a plan to shorten the constitution and by-laws of bull associations, but so far a definite form has not been worked out. He called attention to the splendid results which are now showing up in regard to the increased production of the daughters of bull association bulls compared with the dams of these daughters. Records have been secured in Pennsylvania, Kentucky and Tennessee. He emphasized the fact that at present it is difficult to secure records of daughters of bull association bulls due to the fact that there are only three sections in the United States having both cow testing associations and bull associations in operation.

Report of Calf Club Committee. Mr. E. J. Perry, New Jersey, chairman of the committee, made a brief report stating that the committee has been working on a program for calf club meetings and a uniform system of record keeping. A discussion of club work was entered into and a motion was made by Mr. C. S. Rhodes of Illinois, that the committee on calf clubs for next year be instructed to consider the relations of the dairy calf club work to that of dairy extension work and to make recommendations with regard to better coördination of the work of the club specialist and dairy specialist. The motion was carried.

Report of Committee on Cost of Production. Mr. Moffitt of Pennsylvania, made a brief report of the work of this committee stating that some work had been carried on in Pennsylvania in connection with cow testing association work.

Report of Committee on Milk Campaigns. A very complete and interesting written report was submitted by Miss Jessie M. Hoover, Milk Utilization Specialist, Dairy Division, Washington, D. C., chairman of the committee.

Report of Committee on Dairy Council Work. A very complete written report was submitted by Professor W. P. B. Lockwood of Massachusetts, chairman of the committee.

Report of Dairy Products Committee. An oral report was made by Mr. L. W. Morley, Pennsylvania, chairman of the committee, in which he outlined the work of the committee which has been

along the lines of improving the quality of butter and ice cream and some work has been done on over-run and marketing problems.

A nominating committee was appointed which made the following report: New officers elected were, for chairman, L. W. Morley, Pennsylvania; vice chairman, C. S. Rhodes, Illinois and secretary-treasurer, C. A. Hutton, Tennessee.

The meeting then adjourned to meet again Tuesday evening.

Tuesday evening October 9, the meeting was called to order by Mr. L. W. Morley, chairman, who called on Mr. Brownell of Michigan and Mr. Harmon of Missouri to open a discussion relative to district diary specialists. Mr. Brownell told of the work of the district dairy specialists in Michigan and outlined a plan by which they hope to have a specialist of this kind for each eight counties in the state. Mr. Harmon stated that they now have two district dairy specialists in Missouri and plan to put on at least three more in the near future. These specialists are assigned to certain counties or districts for specific work under the direction of the dairy project leader. The principal features of the work done by those specialists in Missouri is along the line of cow testing associations, bull associations and feed production. They are required to report at headquarters once each month for conferences. All the salary and expenses are paid from State Extension funds and the work is confined to counties not having county agents.

Mr. Moffitt of Pennsylvania was asked to explain the work in regard to the cost of milk production which has been carried on in Pennsylvania. He stated that considerable work had been done in connection with the cow testing associations and that the figures had been used by the Philadelphia milk dealers and dairymen in the fixing of prices. He emphasized the importance of this kind of work and suggested that it adds a new interest to cow testing association work and makes these associations more far-reaching.

The work is done entirely by the cow testing association testers. Record forms are furnished by the extension service of the state. Mr. J. N. McClain of the Dairy Division, Washington, D. C.,

suggested that cost accounting was really investigational work rather than extension or demonstration work. Mr. Moffitt explained that the results were similar to cow testing association work but were more far-reaching and valuable since they included more items of expense and were really more accurate in his respect than cow testing association records.

Mr. Harmon moved that a committee on cost accounting be appointed and instructed to report on methods for this work and forms to be used. The motion was carried.

Plans for the year's work were then outlined by the chairman of the various committees after which the section adjourned to meet with the general session of the American Dairy Science Association.

PERSONNEL OF COMMITTEES IN DAIRY EXTENSION GROUP

Chairman, L. W. Morley, Penn. State College
Secretary-Treasurer, C. A. Hutton, Knoxville, Tenn.
1923–1924

Dairy Products

J. D. Brew.....Ithaca, N. Y.
A. W. Rudwick.....Ames, Iowa
G. N. Toby.....Knoxville, Tenn.
S. C. Thompson.....Dairy Division, Washington, D. C.

Feeding

E. B. Fitts.....State College, Pa.
C. B. Finley.....Ames, Iowa
W. J. Keegan.....Clemson College, S. C.
A. R. Merrill.....Storrs, Conn.
H. A. Harper.....Ithaca, N. Y.

Milk Campaigns

Miss Jessee Hoover.....Dairy Division, Washington, D. C.
W. B. Lockwood.....Amherst, Mass.
Miss Gladys Stillman.....Madison, Wis.
Miss Dorothy Bulkley.....Storrs, Conn.
Miss Mary E. Thomas.....Baton Rouge, La.

Bull Associations

L. A. Higgins.....Starkville, Miss.
C. G. Cushman.....Clemson College, S. C.
M. J. Regan.....Columbia, Mo.
Ivan McKillip.....Columbus, Ohio.
A. R. Merril.....Storrs, Conn.

Calf Clubs

E. J. Perry.....New Brunswick, N. J.
E. M. Harmon.....Columbia, Mo.
F. A. Buchanon.....West Virginia
R. H. Olmstead.....State College, Pa.
C. A. Hutton.....Knoxville, Tenn.

Cow Testing Associations

G. L. Tailby.....Ithaca, N. Y.
A. J. Cramer.....Madison, Wis.
E. A. Hanson.....St. Paul, Minn.
C. R. Gearhart.....State College, Pa.
A. C. Baltzer.....East Lansing, Mich.
J. C. McDowell (advisory).....Dairy Division, Washington, D.C.

Professor G. C. White gave the following report for Section IV.

The section held a two hour session on the evening of October 9 with twenty states represented. Other unofficial delegates from these states and the United States Department of Agriculture were present. Mr. Cummings of the American Guernsey Cattle Club was also present.

Two foreign delegates, Atsushi Mujawaki, M.S., of the Department of Dairy and Meat Technology, Hokkaido Imperial University, Japan and A. Poole Wilson, Dairy Inspector, Department of Agricultural and Technical Instruction for Ireland were called upon and told briefly of cow testing and record making in those countries.

The Breed Relations Committee was called upon for its report. The following comprise this committee: G. C. White, Chairman, Connecticut, J. B. Fitch, Kansas, C. E. Wylie, Tennessee, W. M. Regan, California, W. W. Yapp, Illinois, A. A. Borland, Pennsylvania, and H. N. Colman, Oregon. The committee met two days previous (Colman absent) and acted upon several matters. Dr. Eckles, Professor Harris, Mr. Musser of the American Guernsey Cattle Club, Mr. Baker of the American Jersey Cattle Club, Mr. Inman of the Brown-Swiss Breeders' Association, and Mr. Gardner of the Holstein-Friesian Association of America were also present.

The following matters presented by the committee chairman were duly considered and adopted by the Official Testing Section.

1. Cows owned by state colleges admitted to Advanced Registry without fees. This idea was adopted by resolution at the 1922 meetings. Professor Wylie handled this and he was successful in obtaining the removal of Advanced Registry fees with associations where the requirement obtained.

2. Uniform guarantees to the colleges against delinquent testing accounts. Professor Regan has had this matter under consideration since August. The Breed Relations Committee instructed Professors Regan and Harris to prepare a resolution as a basis for negotiation with the cattle clubs. This resolution was read and adopted by special vote by the Official Testing Section.

3. Uniform drug and feed rules for cows under test. As is the case with other important matters, each club has its own particular ideas about what the breeder can or cannot do. This confuses the supervisor. Professor Yapp has had the matter under consideration only since August. The Committee recommended that he be given more time to work this out by negotiating with the Cattle Clubs.

4. Uniform two day report blanks have been in use since April 1 with general satisfaction. Improvements will be made at successive reprintings as rapidly as possible. The chief difficulty at present is the size of the blank. A larger blank would make it possible to correct most of the present objections.

The chairman is working upon a uniform preliminary report blank. At present it is not possible to get all of the things wanted by different clubs on one card. It is hoped that a blank will be ready by January 1, 1924.

5. Preliminary dry milking. Very little new data has come to light since it was thoroughly studied by the Committee in 1922. The Committee gave consideration to the check method suggested by Mr. Baker of the American Jersey Cattle Club. It still feels that the dry milking is necessary to set a time for the beginning of the test period as well as to guard against attempt at fraud. Mr. Baker's method can well supplement this and it is hoped that some such method will be employed by other Associations. The representatives from other clubs spoke very strongly against dropping the preliminary milking. The space in the uniform

two-day report blank for the milk and test of the preliminary milking very greatly strengthens the official test. All but about ten states are now enforcing the preliminary dry milking on all breeds. The committee recommended that the question be referred to the Investigation Committee of the Official Testing Section.

6. One versus the two day test. In 1922 the American Jersey Cattle Club officials stated that they were thinking of accepting the one day test. They were requested to give the Committee a chance to study the problem. Professor Colman of Oregon was able to do some work along this line but as yet it is too scant to be conclusive. The Breed Relations Committee recommended that this be referred to the Investigation Committee.

7. The Committee, since the last meeting, requested the several Breed Associations to print the uniform rules of the American Dairy Science Association, but some of them did not wish to because they were not being enforced by all States.

8. The nomination committee (Regan, Hooper and Ragsdale) presented the names of the officers for re-election. The rules were suspended and the recommendation prevailed, R. T. Harris, President, H. N. Colman, Vice-President, and G. C. White, Secretary, being re-elected.

9. New Breed Relations Committee appointed: W. M. Regan, California; J. B. Fitch, Kansas; M. H. Campbell, Illinois; C. E. Wylie, Tennessee; A. A. Borland, Pennsylvania; J. R. Dice, North Dakota; G. C. White, Chairman, Connecticut.

10. New Investigation Committee appointed: W. W. Yapp, Illinois, Chairman; J. B. Fitch, Kansas; A. A. Borland, Pennsylvania; J. J. Hooper, Kentucky.

Report of first meeting with the National Research Council presented by J. A. Gamble:

"It was my pleasure and privilege as your delegate, to attend the annual meeting of the National Research Council on April 22, 1923, in the Research Council, 1701 Massachusetts Avenue, N. W., Washington, D. C.

The meeting was called to order at 10:15 by Dr. Lillie, President. There were twenty-five official delegates present together with six others present by invitation. The Societies represented were Botanical Society of America, American Genetic Association, American Society of Zoologists, American Society for Horticultural Science, American Society of Animal Production and the American Dairy Science Association, American Society of Agronomy, Society of American Bacteriologists, Botanical Society of America, American Association of Economic Entomology, Ecological Society of America and Society of American Foresters.

It is apparent that all of the National Associations interested in biology and agriculture are represented in this Division of the National Research Council.

One could not help but appreciate the splendid opportunities offered the different groups by the National Research Council to discuss common problems. It is apparent also that the Council offers a means for the development of projects which could not otherwise be undertaken.

The matters discussed at the meeting related to the appointment of officers and committees, reports from the representatives of different Societies listed and the admittance to the National Research Council of the American Dairy Science Association and the American Association of Animal Production.

The application of the American Dairy Science Association was the first to be acted upon and the acceptance into the National Research Council formally passed. This was followed by the acceptance of the American Association of Animal Production.

The Committee on Food and Nutrition which was ordered continued: L. B. Mendel of Yale, Chairman; H. C. Sherman, Columbia University; C. L. Alsberg, C. F. Langworthy, Graham Lusk, E. V. McCullum, L. B. Mendel, J. R. Murlin, Alonzo E. Taylor, Miss Ruth Wheeler.

Subcommittee on Animal Nutrition as follows: E. B. Forbes, C. H. Eckles, H. S. Grinley, F. B. Morrison, C. R. Moulton, R. A. Pearson, to which were added F. G. King and L. J. Cole.

The question was raised by your representative as to the field which the activities of this committee were supposed to cover.

Suggesting that there were certain phases of animal production which were not included in the scope of the Food and Nutrition Committees. It was accordingly

Moved: That the Division invite the American Dairy Science Association and the American Society of Animal Production to make recommendations to the Division with regards to such Committees as they desire to have appointed.

In conference with E. W. Sheets, delegate of the American Society for Animal Production, it was suggested that a joint report be prepared by both societies and prepared as one report to the Division of Geology and Agriculture of the National Research Council.

It seemed to us that there should be subcommittees on Genetics and on Animal and Plant Breeding.

Following the suggestions made at the Syracuse meeting by your representative, President A. A. Borland appointed the following as a committee for advice regarding committees and personnel to report the American Dairy Science Association in the National Research Council: R. R. Graves, Chairman; C. H. Eckles, R. S. Breed and J. A. Gamble."

The annual report of the Eastern Division for the year 1922–23 was given by Professor R. C. Fisher.

The second annual meeting of the Eastern Division of the American Dairy Science Association was held in connection with the Eastern States Exposition at Springfield, Massachusetts, September 19, 1923.

The following is a brief summary of the program presented:

1. Get-together luncheon and results of judges contests:

Ten states were represented at a get-together luncheon, coaches, students, superintendents and judges of the dairy-cattle and dairy products judging contests were invited. Results of the dairy products judging contests in which six teams competed were announced by the superintendent of the contest, Mr. Wm. White of the Dairy Division, United States Department of Agriculture. This contest was inaugurated two years ago, largely

through the efforts of the Eastern Division. Four products, milk, butter, cheese and ice cream are judged. A beautiful trophy of bronze, symbolizing the farm dairy products and the gifts of the dairy industry to mankind was donated by the eastern dairy interests and goes to the running team each year. The results of the contests are briefly as follows:

Dairy products: New Hampshire, Connecticut, Cornell, Maryland, Pennsylvania, Massachusetts.

Dairy cattle: Connecticut, Maryland, Cornell, Maine, Massachusetts, Pennsylvania, New Hampshire, Syracuse.

2. Report of Rules Committee on Student's Judging Contest by H. F. Judkins:

Professor Judkins presented the report of the Rules Committee. This report was based on a discussion at a meeting held the previous evening, at which were present five members of the United States Dairy Division and five coaches of the judging teams. At this gathering it was the concensus of opinion that Rule 14 of the National Dairy Products Rules was non-essential and should be abolished and that the following should be adopted in its place; "The samples of all products used in the contest must be selected from the market and from the National Dairy Show Exhibit."

Considerable time was given over to the discussion of this point at the general session and the following was adopted as expressing the recommendation of the Eastern Division:

> It is the sense of this meeting that it would be entirely proper and within the power of the officers of the American Dairy Science Association to request the National Dairy Association to place the Dairy Products Judging Contest back on the program of the National Dairy Show this year. It being understood that the products for this contest will be obtained from the market and not from the exhibits of the National Dairy Show.

As our national president, Professor Borland was present at the meeting a copy of the resolution was at once presented to him so he might take such action as he deemed necessary.

3. Dairy Extension Problems:

J. D. Brew, New York, Chairman. Professor Brew presented a very interesting and instructive paper on Dairy Extension

Problems. The high points brought out in the paper and the discussion which followed were:

(1) That the majority of extension departments were handicapped by the lack of funds.

(2) That there are certain types of problems or research work that cannot be carried out in the field; that, therefore, there is urgent need for closer coöperation between the extension worker and the experiment station worker.

(3) That there is need for more coöperation between the workers of the different states.

4. Interstate Coöperative Dairy Problems by G. C. White and Dr. E. S. Guthrie:

Professor White outlined the coöperative plan of exchanging sires between the Massachusetts Agricultural College, the New Hampshire State College and the Connecticut Agricultural College.

He further cited the possible coöperation study that might be carried on as to what objects should the College Dairy Herd be maintained.

Dr. Guthrie pointed out the good that may be derived from closer coöperation between states on problems that are common to each. He cited illustration of coöperative work. (1) Dr. Ellenberger of Vermont and Dr. Guthrie of New York (2), Judkins of Massachusetts and Fisher of Connecticut.

5. Courses of Study:

Professor White, in absence of Dr. H. B. Ellenberger, presented the report of this Committee:

The high points are as follows:

(1) There necessarily is and should be a great deal of variation in the Dairy curriculum of different institutions.

(2) Students should receive thorough grounding in the fundamental sciences related to the Dairy Industry.

(3) That practical work and experience may best be gained outside of College.

(4) That it would be desirable to require at least 3 months actual experience in Dairy Plant work for those majoring in Dairy Production.

6. Relationship of Colleges to Commercial Dairy Interests by R. C. Fisher:

High Points of the discussion:

Committees of the Eastern Division met with committees from the Commercial Dairy interests to study:

(1) Type of Courses best meeting needs of the industry.

(2) Research problems that need working out, and how such work may best be carried on.

(3) Placement of our students both for permanent and temporary positions.

7. Election of Officers:

The following officers were elected for the ensuing year: Chairman, R. C. Fisher; Vice-Chairman, A. A. Borland; Secretary-Treasurer, R. W. Smith, Jr.

The report of the annual meeting of the Southern Division was given by Professor J. A. Gamble. The report of this meeting was printed in the Journal of Dairy Science, vol. vi, no. 4, July, 1923, page 373.

Following these reports the eighteenth annual meeting of the American Dairy Science Association adjourned.

The December ballot showed the re-election of the following officers for 1924: President, A. A. Borland, State College, Pennsylvania; Vice-President, O. E. Reed, East Lansing, Michigan; Secretary-Treasurer, J. B. Fitch, Manhattan, Kansas; Editor, J. H. Frandsen, Lincoln, Nebraska.

Report of Rules Committee for Students Dairy Products Judging Contest at Eastern States Exposition and special committee designated by chairman Ruehe to report for the Students Dairy Products Judging Contest Committee of the American Dairy Science Association:

The following report is based on a discussion at a meeting held at Hotel Bridgeway, Springfield, Massachusetts, Monday evening, September 7, at which the following were present: Campbell, Smith, White, Fryhofer, Williams, of the United States Department of Agriculture; and Harvey, Maryland; Combs, Penn-

sylvania; Judkins, Massachusetts; Fisher, Connecticut; Guthrie, New York; Lockwood, Massachusetts.

At a meeting at the Yates Hotel, Syracuse, New York, October 9, the following were present: Guthrie, Thompson, Harvey, Gamble, Potts, Kelly, Fisher, Judkins.

The following points were discussed:

1. Relation of judging contest and score card committee of the American Dairy Science Association to those in charge of formulating government score cards. The discussion brought out the points (1) that established government score cards might be modified to suit the American Dairy Science Association. (2) The new cheese score card printed in the "Handbook for Use in Inspection Law" was modeled after Wisconsin Standards, where a large percentage of our cheese is made. (3) The United States Department of Agriculture should be the clearing house calling the attention of the American Dairy Science Association score cards committee to proposed changes in cards and getting their action thereon.

It was moved and carried that the final score card should be the result of close coöperation between the American Dairy Science Association and other parties involved in the preparation of score cards.

It was pointed out that it did not matter as much what the score card was as that there should be uniformity in United States Department of Agriculture cards and those used in the judging contests.

It was also pointed out that once a score card becomes established as has a score card for butter it should be let alone unless there is some extraordinary reason for change.

2. The cheese score card. It was the sense of the meeting that the attention of the American Dairy Science Association score card committee be called to the great discrepancy between the United States Department of Agriculture and the American Dairy Science Association cards with a view to neutralizing the present difficult situation.

3. The use of the government score card for milk. It is recommended that the American Dairy Science Association score card

committee give thorough consideration to the difference in score allowed for flavor on the United States Department of Agriculture and the American Dairy Science Association score cards so as to bring uniformity about if possible.

After considering these three points at our meeting this morning it was recommended that all score cards for dairy products followed by the United States Department of Agriculture be adopted by our association for the period of one year, as a trial, with the understanding that if it is satisfactory that they will be permanently employed in our student judging contests.

It is further recommended that in order to simplify the handling of the students dairy products judging contests, that the duties of the committee on students dairy products judging contest include the question of score cards and commercial grades and standards, leaving the matter of legal standards to a separate committee.

4. The inclusion of ice cream in the national contest and score card for same.

Recommended that ice cream be included in the national contest using the American Dairy Science Association score card for want of anything better, confining the scoring to flavor, body and texture, color and package, and that the American Dairy Science Association score card committee work out a standard system of cuts on these items.

The committee this morning recommended that in view of the present unsettled condition with regard to the score card and grades and standards on ice cream, that it be not included in the regular contest next year; we suggest, however, that a separate judging be conducted by the teams, at which the coaches and a representative of the United States Department of Agriculture act as judges for the purpose of developing a satisfactory score card and commercial grades and standards.

5. The method of scoring criticisms.

Recommended that when a cut is made on any item the criticism be stated whether good or bad. When no cut is made no criticism is necessary. That in grading criticisms the maximum cut for each item shall be one point. It was pointed out that this

greatly simplified grading criticisms over the rule providing that not more than 5 points be scored off on any one sample.

6. The number of samples of each product to be included in the contest.

Recommended that five samples be used instead of ten, especially if ice cream is used in the contest. It was pointed out that a sufficient range of defects could be obtained in five carefully selected samples.

In view of the fact that ice cream be not included, recommended that ten samples of each product be used.

7. Number of representative samples to be placed before students before contest begins; should not judge's scores and criticisms be placed on the samples.

Recommended that two samples with score and criticism be placed before students.

Recommended that three representative samples of each product showing good, medium and poor quality be set out with the judges' scores and criticisms attached. The contestants shall have access to these samples, five minutes for each product, just previous to the scoring of the contest samples.

8. The importance of a commercial and United States Department Agriculture judge on products when both can be obtained.

It was felt that both a commercial and United States Department of Agriculture judge should be used on all products possible.

9. Voted in so far as past experience has proved that the rules of the contest have come out too late to be of greatest service in preparing teams, that rules be published at least one year in advance, i.e., new rules adopted at the annual meeting of the American Dairy Science Association would not become effective until a year later. Rules for the next contest shall be this year's rules with the changes authorized at this meeting.

10. Uniformity in work of official judges.

The discrepancy between the standard of the cheese judges at the Eastern States and National contests in 1922 was pointed out and it was voted that the rule providing "no judge can serve for more than 2 consecutive years and not more than one judge can hold over from one year to another" be abolished as it defeats the purpose of obtaining uniformity in standards of judging.

11. The use of standard terms by judges.

Recommended that official judges, in making criticisms stick rigidly to the terminology laid down in the prepared system of scoring cuts that have been uniformly used by the coaches in training teams.

12. Should coaches help in grading criticisms.

Recommended that it is very important that it be stated in the rules that coaches aid in grading criticisms.

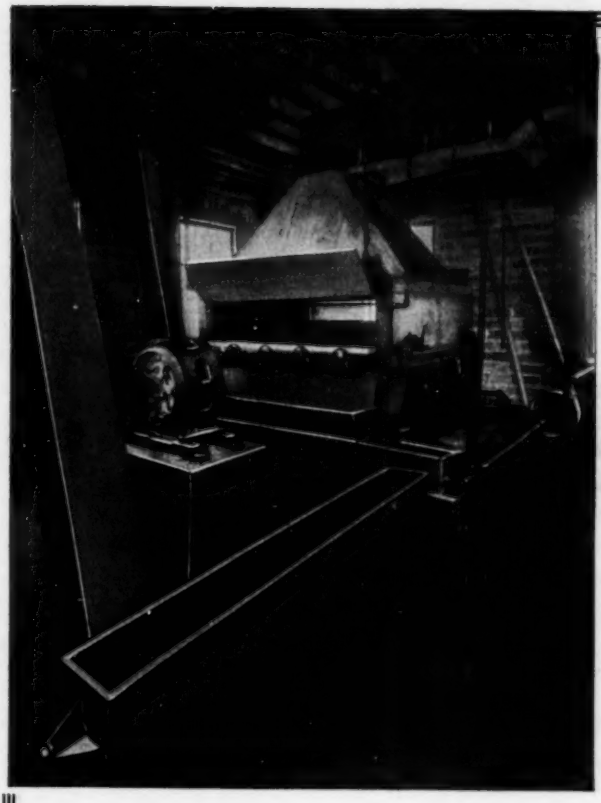
Grading of criticisms shall be done by the official judge but coaches are invited to be present.

13. Action on Rule 14 providing "no member of the teaching, extension or experimental staff of a college entering a team may act as an official or be in any way connected with the dairy products of the National Dairy Show" be abolished and the following adopted in its place: "the samples of all products used in the contest must be selected from the market and not from the National Dairy Show Exhibit."

Recommended that Rule 14 be modified to read as follows: "No coach or any person aiding in training a team may act as an official or be in any way connected with the Dairy-products exhibit of the National Dairy Show."

14. Importance of the Contest.

Recommended that an attempt be made to emphasize more strongly the importance of the contest and raise its prestige.



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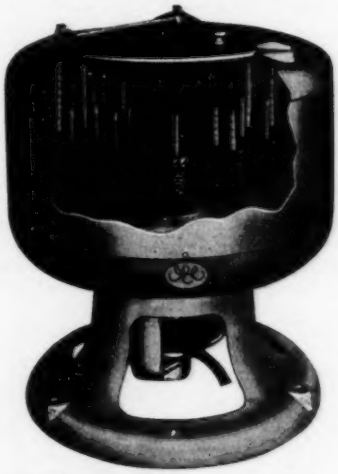

See Jour. Dairy Sci., Jan. 21, 1921, page 32

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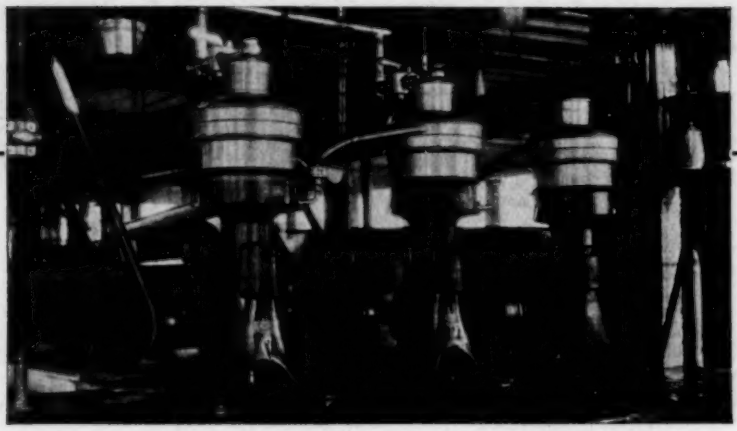

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